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Environmental impact assessment and monitoring in aquaculture

Requirements, practices, effectiveness and improvements

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Clockwise from top left: seabream cages, Izmir Bay, Turkey (courtesy of Guzel Yucel Gier); carp fingerling ponds, Antsirabe plateau, Madagascar (courtesy of FIMA Photo Library); fish ponds for culture of Nile tilapia, African catfish and African bonytongue, Cameroon (courtesy of José Aguilar-Manjarrez); intensive shrimp farming ponds, Baja California, Mexico (courtesy of Acqua & Co S.r.l; FIMA Photo Library).

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by
Aquaculture Management and Conservation Service
Fisheries and Aquaculture Management Division
FAO Fisheries and Aquaculture Department

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Preparation of this document

This document contains the main outputs of Component 2 of the FAO project "Towards sustainable aquaculture: selected issues and guidelines". Component 2 focused on environmental impact assessment and monitoring in aquaculture, in particular on the relevant regulatory requirements, the practice, the effectiveness and suggestions for improvements.

The report includes four regional review papers on EIA and monitoring in aquaculture in Africa, Asia-Pacific, Europe, Latin America and North America, a special study on EIA as applied to salmon aquaculture, as well as a global review and synthesis report which draw on the findings of the review papers, covering relevant information from more than 35 countries. The report includes a review of implementation by countries of environmental impact assessment in aquaculture according to information reported to and collected by FAO, and a case study on EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay, the Philippines.

In addition, this document provides both the Report of the Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture, held at FAO headquarters in Rome from 15 to 17 September 2008, which reviewed and discussed findings of all above review and synthesis papers, as well as possible elements for guidelines, which are based on these reviews and the outcomes of the workshop.

FAO's Aquaculture Management and Conservation Service (FIMA) of the FAO Fisheries and Aquaculture Department commissioned the preparation of the review and synthesis papers and organized the technical workshop, with financial support provided generously by the Government of Japan. FAO/FIMA acknowledges with appreciation the technical inputs by all experts, authors and workshop participants, all of whom have contributed to this publication. Coordination of Component 2 activities and technical review of this document was done by FIMA staff including U. Barg (lead), D. Soto and J. Aguilar-Manjarrez, with the assistance of J. Hambrey (editing, synthesis, facilitation of workshop discussions) and J.L. Castilla (desktop publishing).

The printed version of this document provides the introductory pages including the Foreword, Executive summary and the Background, as well as the Global review and Synthesis of reviews of EIA and monitoring in aquaculture in four regions and for salmon aquaculture, which is presented in Part 1 of this publication. The accompanying CD-ROM attached to the inside back cover provides readers with the full content of this publication including (see Contents): all of Part 1 - Reviews and synthesis; Part 2 - Workshop report; Part 3 - Towards policy guidelines; and Part 4 - Appendices.

Abstract

This document contains the main outputs of Component 2 of the FAO project "Towards sustainable aquaculture: selected issues and guidelines". Component 2 focused on environmental impact assessment and monitoring in aquaculture, in particular on the relevant regulatory requirements, the practice, the effectiveness and suggestions for improvements. The report includes four regional reviews on EIA and monitoring in aquaculture in Africa, Asia-Pacific, Europe, Latin America and North America, a special study on EIA as applied to salmon aquaculture, as well as a global review and synthesis report which draw on the findings of the review papers, covering relevant information from more than 35 countries. In addition, this document provides the Report of the Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture, held at FAO headquarters in Rome from 15 to 17 September 2008.

The global and regional reviews in this study and the associated technical workshop draw on experience from throughout the world in the application of EIA and monitoring to aquaculture development. In practice most aquaculture is small-scale and is not subject to EIA or rigorous monitoring. More emphasis needs to be placed on environmental management frameworks which can address the environmental issues associated with large numbers of small-scale developments – including strategic environmental assessment, risk analysis, management plans for waterbodies and/or groups of farms, monitoring and response procedures.

Where EIA is applied there is mixed experience. Several weaknesses were identified in the regional reviews and at the workshop, including lack of consistency in assessment; lack of appropriate standards; lack of integration between levels and divisions of government; inadequate or ineffective public consultation; lack of assessment skill and capacity; limited follow-up in terms of implementation and monitoring; and excessive bureaucracy and delays. There is very little hard evidence on cost effectiveness.

Monitoring is of fundamental importance to effective environmental management of aquaculture, and without which EIA itself is largely pointless. The main weakness identified was limited implementation of monitoring requirements as developed in EIA environmental management plans, and limited analysis, reporting and feedback of farm level and wider environmental monitoring programmes into management of individual farms and the sector as a whole.

The key to more effective use of both EIA and monitoring procedures will be to nest them within a higher level strategic planning and management framework, including clear environmental objectives and quality standards. More rigorous risk analysis should be used to inform the focus of both EIA and monitoring.

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Includes a CD-ROM containing the full document (648 pages).

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Towards policy guidelines

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The participants at the FAO Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture, held from 15 to 17 September 2008, in Rome, at FAO headquarters, reviewed, discussed and contributed to the completion of the above materials, as well as to finalization of the Workshop report. Their contact details can be found in Annex 2 of the Workshop report, Part 2 of this publication.

Foreword

By providing nearly 50 percent of fish consumed worldwide, aquaculture increasingly contributes to global food fish supplies and to the alleviation of malnutrition, hunger and poverty, especially in developing countries. However, some aquaculture practices have also caused negative effects, including environmental impacts. Concerns and criticism have been voiced against some aquaculture developments. A key issue in this context is to provide adequate information about the environmental impacts of aquaculture operations. Such information is also important for the management and regulation of aquaculture developments, both at farm and sector levels. The FAO Code of Conduct for Responsible Fisheries, adopted in 1995, encourages governments and concerned stakeholders to promote environmental assessment and management of aquaculture.

The FAO Ministerial Meeting in 1999 and the Committee of Fisheries Sub-Committee on Aquaculture in 2002 reiterated the need for enhanced efforts by the international aquaculture community to work towards more sustainable and responsible aquaculture production practices. In 2003, the second session of the COFI Sub-Committee on Aquaculture welcomed the offer of the Government of Japan to financially support targeted efforts of the FAO Fisheries and Aquaculture Department in addressing most pressing issues of aquaculture sustainability worldwide. With the generous support of the Government of Japan, FAO's Aquaculture Management and Conservation Service (FIMA) developed and implemented the FAO project "Towards sustainable aquaculture: selected issues and guidelines" (GCP/INT/936/JPN). The project focused on the following themes:

1. Food safety of aquaculture fish
2. Environmental impact assessment and monitoring in aquaculture
3. Use of wild fish/fishery resources for aquaculture production
4. Use of wild fish and/or other aquatic species to feed cultured fish and its implications to food security and poverty alleviation
5. Ecosystem approach to aquaculture

The second project component on **Environmental Impact Assessment and Monitoring in Aquaculture** aimed to address key issues of environmental assessment and monitoring in aquaculture with a view to generate strategic advice and technical guidance information for use in policy-making, capacity-building and training in the sector, in particular on improved use of EIA and monitoring approaches in aquaculture, and on complementary measures useful and effective in further promoting sustainable aquaculture development. This second component complemented efforts under the fifth project component on the development of guidelines on the ecosystem approach to aquaculture. The outputs generated by this project, including Component 2, are expected to assist FAO member countries in the promotion and implementation of the provisions of the Code of Conduct for Responsible Fisheries.

FIMA greatly appreciates all expert contributions leading to the publication of this Technical Paper, including those by reviewers, workshop participants, resource persons as well as by FAO colleagues in the Fisheries and Aquaculture Department and the Development Law Service.

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Executive summary

The Aquaculture Management and Conservation Service of FAO's Fisheries and Aquaculture Department conducted review studies on environmental impact assessement (EIA) and monitoring in aquaculture in Africa, Asia-Pacific, Europe, North America, Latin America and in marine salmon cage aquaculture, covering more than thirty-five of the top aquaculture producing countries in the world. The reviews studied the application of EIA and monitoring in aquaculture focusing on: (i) regulatory requirements; (ii) practice; (iii) effectiveness; and (iv) possible improvements of EIA and monitoring in aquaculture. These reviews were synthesized into a global review. A technical expert workshop (September 2008, Rome, FAO) reviewed and discussed the findings and suggestions of all reviews, and developed relevant conclusions and recommendations for use by authorities, policy and decision-makers, private sector and other stakeholders interested in the promotion of sustainable aquaculture.

GENERAL SCOPE OF EIA AND MONITORING

Environmental impact assessment may be defined as: *"The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made".*[1]

In practice, most countries have their own definitions and guidance, although these are broadly similar across the globe. Full EIA is usually conceived as applying to new, large-scale developments. EIA serves two main purposes: to inform a consenting or licensing decision; and to identify mitigation measures which will minimize any possible environmental impacts.

Monitoring may apply to:

- the practical implementation of conditions or plans arising from an EIA;
- the state of the environment in the vicinity of a farm which has been subject to EIA (by the farmer or by the authorities); and
- the state of the environment more widely, which may be influenced by one or many farms and other activities.

APPLICATION OF EIA TO AQUACULTURE

EIA is most commonly applied to intensive marine finfish culture (especially salmon culture) and to proposals for large scale shrimp farm developments. However, some countries with significant large-scale aquaculture industries (including Japan, Thailand, some states in the United States of America and parts of Europe) do not apply EIA to aquaculture development, but rather rely on a range of alternative environmental management procedures.

Full EIA is not applied to the bulk of global aquaculture production. This is because most aquaculture production is small-scale, and in many cases is a traditional activity. It is notable that EIA is not generally applied to agriculture for similar reasons. However, there are less rigorous forms of environmental assessment (environmental declarations, initial environmental assessment, etc.) which are increasingly applied as part of the permitting or licensing procedure for small-scale aquaculture developments.

The variation in the degree and nature of application is important, and reflects the diversity of aquaculture enterprises and development context. EIA is just one tool for

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[1] IAIA. 1999. Principles of Environmental Impact Assessment Best Practice. www.iaia.org/modx/assets/files/Principles%20of%20IA_web.pdf.

the environmental management of aquaculture, which needs to be adapted according to circumstances.

EIA PRACTICE IN AQUACULTURE

EIA practice varies significantly, although usually follows standard national and international guidelines. The first stage is usually ***screening*** to determine if EIA, or what level of EIA, is required. Most countries apply thresholds which may include area, production volume, intensity, technology or species. In some cases EIA is triggered by specific characteristics, such as introduction of alien species. Several of the reviews presented in this publication reveal the need for more rigorous application of risk assessment as part of the screening process, and this was strongly endorsed by workshop participants.

The second phase – ***scoping*** to determine the issues to be addressed in the assessment – should also be informed by a risk assessment process. The application and thoroughness of risk assessment at this stage is highly variable, and, when neglected, may allow for a lack of focus in the EIA itself. It is arguable that key stakeholders should be involved at this stage, but this is unusual in practice.

Assessment of significance of the possible impacts lies at the heart of EIA, and depends crucially on the skill, knowledge and impartiality of the EIA practitioner. Given that in many cases the practitioner is the developer or someone hired by the developer, quality control of this stage is crucial. Some countries address this through registers of approved EIA consultants; others through training or standard review procedures. Public disclosure of EIA reports allows for wider public review and scrutiny.

In practice the key to more consistent and rigorous assessment is to develop clear environmental objectives and quality standards which serve as benchmarks for the assessment. In many countries these remain inadequate or inappropriate to particular waterbodies. Effective assessment also requires accurate ***prediction*** of possible effects. Modelling of benthic effects and chemical dispersal/assimilation is well developed for marine finfish farming, and is slowly being extended to include wider and more subtle effects on the environment. Such modelling approaches may be more difficult for complex freshwater and estuarine systems with large numbers of farms, but simple mass balance predictions can give useful insights.

Stakeholder consultation is often a specific requirement of more comprehensive EIA and is generally recommended in most EIA guidance materials. The reviews show that with a few notable exceptions, public participation in scoping and assessment is limited. This probably reflects the significant costs and political complexity of public involvement, and the lack of decision-making procedures which can cope with the range of opinions and interests likely to be expressed. While public involvement is to be encouraged – especially in relation to more subjective issues of landscape, cultural and socio-economic impact, and as a form of quality control – the difficulties and sensitivities should not be underestimated. There are important issues relating to national versus local interests, representation, and the power and communication skills of particular interest groups. These dimensions of public consultation must be well understood and well managed.

Mitigation measures and/or an environmental management plan are often seen as key outputs of an EIA, and may serve as conditions for the issue of a consent or licence. However, generic mitigation measures are increasingly promoted through codes of practice or standard regulations. It is important therefore that any mitigation measures identified in an EIA do not simply replicate these standard provisions, but rather focus on much more specific site-related issues.

Decision-making procedures such as consenting or licensing are again highly varied. Usually a large number of institutions are consulted and final decisions made by technical or representative individuals or committees. The degree of stakeholder involvement or participation is often limited. Several of the reviews highlight the lack of coordination and integration between different sectors and levels of government, and the time and cost associated with the process. Others highlight the lack of public involvement at this stage – or where there has been public involvement, the political fallout that may ensue.

Monitoring the implementation of mitigation measures or plans, and the quality of the local environment, was found to be weak in many countries, although authorities in some countries do conduct random checks on farms that have been through the EIA process. Analysis of monitoring information, and feedback into better farm and sector management were also found to be weak, except in the case of some of the major salmon producing countries.

EFFECTIVENESS OF EIA

The reviews were unable to offer significant evidence to demonstrate or confirm the effectiveness or cost-effectiveness of EIA as an environmental management tool. This reflects the lack of a credible baseline; the limited application of EIA to aquaculture; and the lack of effective monitoring, analysis and feedback. Limited application and effectiveness of EIA also seems to be confirmed in FAO's surveys of progress made in the implementation of the Code of Conduct for Responsible Fisheries (CCRF), as described in Part 1 of this publication. In several countries, EIA is seen as a bureaucratic exercise required to obtain a license, rather than as an effective environmental management tool.

MONITORING

The workshop participants agreed that monitoring is the priority for effective environmental management of aquaculture. Without monitoring we have little understanding of the key environmental issues relevant for a given location, or knowledge of the effectiveness of any management interventions, including EIA. Despite this, monitoring was weak in many countries – both at farm level and for the wider environment. Where it is applied, there is often limited analysis and feedback into farm or sector level management. Authorities in some countries, including China, Viet Nam, and many European countries, have embarked on ambitious monitoring programmes for different waterbodies.

Monitoring and associated data analysis can be complex and expensive. Workshop participants agreed on the need for effective scoping and risk assessment to ensure a clear focus for monitoring and cost effective implementation. The existence of environmental quality objectives and standards should also provide a framework for reporting, and increase relevance of the analysis.

There are significant opportunities for greater farmer participation in monitoring programmes. This would increase farmer responsibility at the same time as generating useful applied data. There are examples of this from several countries, including Norway.

INSTITUTIONS AND DECISION-MAKING

Decision-making is a key issue for effective EIA. Several of the reviews highlighted inconsistency; lack of transparency; lack of coordination/integration; and subjectivity. While many of these issues can be addressed through development of agreed thresholds, standards, criteria, and guidance more generally, there will remain a need to make trade-off decisions about highly subjective sociocultural issues, including tradition, community, landscape and so on. This should be explicitly recognized in drawing up EIA and related procedures.

There is huge variation in decision-making structures and procedures to address these issues (e.g. committees, ad hoc panels, governors, commissioners, facilitators) and much experience to draw on.

Another important issue is institutional responsibility for EIA, monitoring and related procedures. The choice of lead institution will inevitably influence the weight afforded different considerations and perspectives. Typically, responsibility is assigned either to the environment department/agency or to the sectoral (fisheries/aquaculture/agriculture) department/agency, although there is a range of other arrangements. There are strengths and weaknesses in both these approaches, with the former tending to be more precautionary and more "neutral", and the latter more supportive of well managed development, and usually better placed to implement and monitor through its stronger contacts with the industry. Whichever takes the lead, it is essential that they work closely together to draw on the strengths and knowledge of each.

STRENGTHS AND WEAKNESSES OF EIA AND MONITORING IN AQUACULTURE

The adoption of EIA legislation in many countries and its application to some forms of aquaculture has undoubtedly raised awareness of the environmental issues associated with aquaculture, and this in itself is likely to lead to better environmental management. It is universally agreed that monitoring is essential for better environmental management.

However, many weaknesses were identified in the reviews, of which the following in particular stand out:

- The difficulty of addressing the cumulative impacts of many small-scale developments through conventional EIA.
- The lack of environmental objectives and standards – especially suited to the local context – against which to assess impacts and design mitigation.
- The excessive scope and lack of focus on key issues of much EIA and monitoring activity.
- The lack of institutions and capacity to coordinate, manage, implement and review EIA, monitoring and environmental management tools more generally.
- The lack of engagement and trust between regulators and farmers.
- Limited participation or engagement of key stakeholders; or where this does take place, poor management and inadequate conflict resolution.
- The lack of effective monitoring, analysis and feedback into sector management, as well as into management of individual farms, or groups/clusters of farms.

These are all indicative of a tendency for governments and regulatory authorities to focus on particular techniques (such as EIA) rather than on an adaptive management system for the sector. It is important that such a system be "nested" with elements at national level, at waterbody level, and at farm level.

OTHER TOOLS FOR THE ENVIRONMENTAL MANAGEMENT OF AQUACULTURE

Regulation

Irrespective of licensing, EIA or sector planning initiatives, many countries have well established legislation and regulation to control and manage pollution and waste discharges from industrial activities. This has been extended to agriculture in recent decades, and many countries now apply controls to aquaculture – especially the more intensive production systems. In some cases these regulations cover almost all the major environmental effects of aquaculture, including: discharge of nutrients and chemicals; import and movement of stock and eggs; introduction of alien species; disposal of mortalities; and product quality. Specific permits or consents may be required for these various activities, and various forms of assessment may be required in order to gain these consents. In effect, this standardizes environmental management and reduces the need to address many issues in EIA. In those cases where EIA is required, it will address the extent to which the farm is expected to be compliant with these standard controls; in a few cases the EIA may inform the nature or level of licence specific consents.

Codes of practice

In recent years codes of practice, best management practices (BMPs), codes of conduct, etc., have been introduced throughout the world – promoted by government, by international organizations, and by the private sector. They are seen as a tool which addresses many environmental management issues while at the same time has the potential to confer market advantage. Perhaps most importantly these can be promoted among large numbers of small-scale producers in situations where both EIA and regulation would be unworkable. BMPs or codes can also be used as a tool within the regulatory process. For example, in the United States of America adherence to BMPs may be set down as a licence condition.

THE WAY FORWARD

A comprehensive set of recommendations was developed at the workshop and these are presented in the workshop report (Part 2 of this publication). Most of these recommendations have been organised and elaborated as key elements for guidelines (Part 3) which presents a brief overview and summary of the main recommendations.

1. Diversity

Aquaculture development and the social, economic and geographic contexts in which it takes place, are hugely varied and management systems should be developed taking into account this diversity.

2. Efficiency

It is essential that the environmental management process is efficient, avoiding delays and waste of resources and efforts, and that it facilitates the responsible development of aquaculture and its contributions to sustainable development.

3. Management framework

EIA and monitoring should be implemented as part of a wider management framework or "system" for aquaculture. At minimum, such a system should comprise: (i) policy and strategy; (ii) agreed environmental objectives and associated indicators, standards and reference points; (iii) mechanisms by which such objectives can be achieved for the sector (e.g. EIA, codes of conduct, regulation, zoning); (iv) monitoring strategy; and (v) feedback mechanisms to inform and refine management interventions. The framework should also define institutional responsibilities and procedures.

Such a system should nest elements at several geographic scales which will depend on geographic, economic and administrative systems, but might include national strategy, waterbody level management plan and farm group or "cluster" plan. It should seek a balance between the need for consistency and a level playing field on the one hand, and the need for flexibility, participation and adaptation to local needs and circumstances on the other.

Strategic environmental assessment (SEA) may be used to inform the development of the management system at different levels.

4. Management units

Effective organization and representation of farmers is a precondition for effective dissemination and application of environmental management measures. Where there are large numbers of small-scale farmers this may require government assistance/facilitation.

In some cases farmers may be organized into small management groups or "clusters". In other cases, authorities may help establish aquaculture "parks", regions or zones in order to streamline and facilitate environmental management and reduce conflict. Care is however needed with any clustering initiative so as not to exacerbate biosecurity (disease) and environmental capacity issues through overconcentrated development.

5. Environmental capacity

Understanding environmental capacity is key to the management of cumulative impact and to answering the question: how much aquaculture can be sustained in a particular area? Although it is often difficult to determine accurately, there are now a variety of approaches which allow rough estimates to be made. These, coupled with effective monitoring, can be refined over time. Again, these estimates may be made at different scales according to the nature of geography, ecology and administrative units.

6. Risk-based approach

Environmental assessment, monitoring and management response all need to be focused on priority issues in order to improve cost-effectiveness. Risk analysis should be a key tool in developing overall strategy and in defining more specific requirements for EIA and monitoring. More attention also needs to be paid to socio-economic issues when considering both consenting and mitigation.

7. Simplicity

Most aquaculture takes place in poor regions. Monitoring regimes should take account of what is practical and feasible, as well as what is scientifically desirable. Minimizing the number of parameters, using local knowledge and indicators, developing simple sampling procedures may all contribute to more widespread, affordable and useful monitoring programmes.

8. Institutions and decision-making

There needs to be clear responsibility for decision-making in planning and consenting procedures, and the skills and capacity to address both technical issues and more subjective cultural and socio-economic issues. The latter may require well-managed public consultation and participation.

Better coordination and integration between different levels and sectors of government is essential to reduce delay and bureaucracy.

Clarity and transparency in decision-making should ensure more thorough quality control, and more predictability and consistency. Publication and easy access to key documentation – and especially to EIA documentation – is essential.

9. Capacity building for environmental assessment and management in aquaculture

Capacity building has multiple dimensions all of which should be addressed:

- rights and responsibilities;
- sector specific guidance and toolkits;
- training;
- availability and dissemination of predictive models, shared access to better information,
- awareness and extension, farmer organisation; institutional processes, coordination, decision support, managing consultation and participation.

All these issues are further elaborated in the global review and synthesis report (Part 1) and more detail and practical examples can be found in the regional reviews and salmon study (Part 1). A specific example of the management of small-scale aquaculture in Bolinao Bay, Philippines, is presented in Part 1. Further discussion and more detailed recommendations can be found in the key elements for guidelines (Part 3) and in the workshop report (Part 2).

Background

INTRODUCTION

Aquaculture is recognized as a significant and continuously growing food production sector (NACA/FAO, 2001; Brugère and Ridler, 2004; FAO, 2006a; 2007; 2009). It provides income, employment and can significantly contribute to supply of much needed protein and food security in general. However, some aquaculture practices have also caused negative effects on the environment and on local communities. The result in many cases has been that serious concerns have been expressed, particularly about the overall environmental sustainability of some aquaculture practices.

Providing adequate and generally accepted information about the environmental impacts of aquaculture operations has proven very useful. Awareness of the environmental impacts of aquaculture has steadily grown over the past decades. There have been many efforts by concerned government authorities, aquaculture producers, scientists, as well as environmental advocacy groups and other stakeholders, at local, national and international levels to address the issues of environmental impacts of aquaculture. As a response, there has been also a general trend to improve environmental assessment and management practices in aquaculture. In the 1970s FAO had already started technical advisory initiatives on assessment and management of environmental impacts of aquaculture, as well as on regulatory, legal, policy and planning measures useful for the management of aquaculture farms and the aquaculture sector as a whole. With a view to further promote the sustainable development of aquaculture, FAO over the past decades, often in collaboration with partners, launched national, regional and inter-regional technical cooperation projects, published relevant technical documentation and guidelines, and promoted international cooperation and networking on sustainable aquaculture development (for example, Beveridge, 1984; Maine and Nash, 1987; Van Houtte, Bonucci and Edeson, 1989; Insull and Nash, 1990; Barg, 1992; FAO/NACA, 1995; Van Houtte, 1995; Insull and Shehadeh, 1996; FAO, 1995; 1997; 1998; Aguilar-Manjarrez and Nath, 1998; GESAMP, 2001; FAO/NACA/UNEP/WB/WWF, 2006; Brugère and Hishamunda, 2007; FAO, 2008a).

Of particular importance for the promotion of sustainable aquaculture has been the development and adoption in 1995 of the FAO Code of Conduct for Responsible Fisheries (CCRF) (FAO, 1995). The CCRF was developed in an intergovernmental negotiation process and is recognized as one of the most significant international governance instruments for fisheries and aquaculture worldwide. The CCRF has recognized both the potential for significant growth in aquaculture as well as the potential of aquaculture practices to cause environmental and social impacts. In its General Principle No. 6.19, the CCRF calls for:

> *6.19 States should consider aquaculture, including culture-based fisheries, as a means to promote diversification of income and diet. In so doing, States should ensure that resources are used responsibly and adverse impacts on the environment and on local communities are minimized.*

More specifically, the CCRF, in its Articles 9.1.2 and 9.1.5, calls for environmental impacts assessment and monitoring in aquaculture (see Box 1). Given the importance of environmental impact assessment and monitoring in aquaculture, the FAO

BOX 1

CCRF Article 9 – Aquaculture Development. Provisions of Articles 9.1.1 – 9.1.5 (FAO, 1995)

9.1 Responsible development of aquaculture, including culture-based fisheries, in areas under national jurisdiction.

9.1.1 States should establish, maintain and develop an appropriate legal and administrative framework which facilitates the development of responsible aquaculture.

9.1.2 States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on the best available scientific information.

9.1.3 States should produce and regularly update aquaculture development strategies and plans, as required, to ensure that aquaculture development is ecologically sustainable and to allow the rational use of resources shared by aquaculture and other activities.

9.1.4 States should ensure that the livelihoods of local communities, and their access to fishing grounds, are not negatively affected by aquaculture developments.

9.1.5 States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities.

www.fao.org/DOCREP/005/v9878e/v9878e00.htm#9

Questionnaires[1] on Progress in the Implementation of the CCRF in its section on aquaculture do include questions to FAO Members regarding the existence and development of regulatory measures and procedures for environmental impact assessment and monitoring in aquaculture. Generally, the responses by FAO Members so far indicated that there is a wide range of diverse types of EIA and monitoring procedures, and that the extent of development, implementation and effectiveness of such EIA and monitoring procedures, where existing, also varies form country to country. An overview and synthesis of countries' responses to CCRF questionnaire items on EIA and monitoring in aquaculture are provided in this publication by Soto, Aguilar-Manjarrez and Irde (2009).

In many cases, EIA and monitoring procedures in aquaculture do not exist, are not sufficiently developed or implemented, and often appear to be inadequately designed to provide key information on changes in the ecological features of the specific environments sustaining given aquaculture practices. Often, there are little or no efforts to ensure regular monitoring of environmental performance and environmental

[1] The CCRF provides that FAO, in accordance with its role within the United Nations system, will monitor the application and implementation of the Code and its effects on fisheries and the Secretariat will report accordingly to the FAO Committee on Fisheries (COFI). All States, whether Members or non-members of FAO, as well as relevant international organizations, whether governmental or non-governmental should actively cooperate with FAO in this work. A questionnaire, developed for use in biannual surveys, is being forwarded to all FAO Members, non-members, regional fishery bodies, inter-governmental and international non-governmental organizations. The responses are compiled by FAO's Fisheries and Aquaculture Department and results are reported to COFI, in form of progress reports which can be found on FAO's home page at www.fao.org/fishery/ccrf/publications/monitoring. Since the establishment of the COFI Sub-Committee on Aquaculture in 2001, progress reports on aquaculture provisions of the CCRF are prepared for the sessions of this Sub-Committee (FAO, 2008b).

BOX 2

EIA and monitoring in aquaculture (FAO, 1997)

When formulating programmes or requirements for environmental assessments and monitoring, due consideration should be given to the diversity of aquaculture practices (including, in particular, the species used and the culture methods applied) and their environmental settings. However, in many cases, particular emphasis will need to be given to simplicity, flexibility and affordability of environmental assessments and monitoring, in order to facilitate the acceptance and enforcement of such measures. Consultation and participation of interested and affected parties in the formulation of requirements for environmental assessment and monitoring should be encouraged. A detailed evaluation of financial, manpower and time requirements for any such effort should precede their implementation to demonstrate their cost-effectiveness and feasibility.

ftp://ftp.fao.org/docrep/fao/003/W4493e/W4493e00.pdf

outcomes of aquaculture farm management measures, after the completion and submission of the EIAs required for the establishment of aquaculture farms.

In view of significant issues associated with the development and implementation of EIA and monitoring schemes in aquaculture, FAO's Technical Guidelines for Responsible Fisheries in support of the implementation of CCRF Article 9 on Aquaculture Development (FAO, 1997) suggested a pragmatic, adaptive and flexible approach to the application and enforcement of regulatory EIA and monitoring requirements in aquaculture (see Box 2).

THE PROJECT

Given the significance of EIA and monitoring requirements in aquaculture governance, a project was developed with a view to addressing information and capacity development needs in many FAO member countries. "Environmental Impact Assessment and Monitoring in Aquaculture" is one component of the FAO project "Towards sustainable aquaculture: selected issues and guidelines" (GCP/INT/936/JPN), which was implemented by FAO's Aquaculture Management and Conservation Service, with the financial support of the Government of Japan.

This project was designed to facilitate the compilation of strategic information which could contribute to improved and effective environmental assessment and management of aquaculture resulting from improved and targeted application of EIA and monitoring approaches in aquaculture. This project resulted in the present publication which provides a first global overview of existing requirements, procedures and practices of environmental impact assessment and monitoring in aquaculture as well as a comprehensive discussion of relevant experiences, effectiveness and suggestions for improvements, including complementary measures useful and effective in further promoting sustainable aquaculture development.

This project facilitated the preparation of five reviews. Four regional review studies were prepared to cover the compilation and review of existing EIA and environmental monitoring procedures and practices in aquaculture in selected countries of the following four composite regions.

Africa:	Egypt, Madagascar, Nigeria, South Africa, the United Republic of Tanzania, Uganda;
Asia-Pacific:	Australia, China, India, Indonesia, Japan, Malaysia, Philippines, Thailand, Viet Nam;

Europe & North America:	Czech Republic, France, Greece, Hungary, Italy, Netherlands, Poland, Spain, Turkey, the United Kingdom of Great Britain and Northern Ireland , as well as Canada and the United States of America;
Latin America:	Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico

A fifth special case study focused on EIA and monitoring in marine cage aquaculture of salmon in Canada, Chile, Ireland, New Zealand, Norway, the United Kingdom of Great Britain and Northern Ireland and the United States of America. A global review and synthesis report was prepared based on these four regional case studies and the salmon aquaculture study.

In the context of this project FAO organized a Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture, held from 15 to 17 September 2008 at FAO headquarters in Rome. The workshop discussed and reviewed the above regional reviews, the special salmon aquaculture case study, a global review and synthesis, an analysis of available CCRF questionnaire responses, national aquaculture sector overviews and national aquaculture legal overviews, and produced a range of conclusions, recommendations and elements for guidelines on EIA procedures, monitoring and environmental management frameworks relevant to aquaculture.

THIS TECHNICAL PAPER

This Technical Paper is organized in four parts. **Part 1** (Reviews and synthesis) provides the global review and synthesis on EIA and monitoring in aquaculture, followed by the four regional reviews and the fifth special case study on EIA in salmon aquaculture, as well as a review of implementation by countries of environmental impact assessment in aquaculture according to information reported to and collected by FAO, and a case study on EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay, the Philippines. The Report of the Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture, held in Rome during 15-17 September 2008 can be found in **Part 2**. Information and guidance developed in Parts 1 and 2 was synthesized to a set of suggested elements which could be useful in developing or advancing policy guidelines on improved environmental assessment and management in aquaculture, and these are summarized in **Part 3** (Towards policy guidelines). Three Appendices compiled in **Part 4** provide readers with background materials on the terms of reference for the preparation of review papers, the description of Project Component 2, and on the use of terms, in particular EIA, monitoring and strategic environmental assessment (SEA).

It is emphasized that information on general principles and elements of EIA requirements, procedures, and related definitions, is generally available, for example, in such publications as produced by the United Nations Environment Programme (Sadler and McCabe, 2002) and the International Association for Impact Assessment (IAIA, 1999).

For the purposes of this Project and this publication, the review of regulatory EIA requirements involved consideration of relevant legal texts. However, since legal texts at times are prone to modifications or amendments, readers are invited to always cross check and search for most recent legal texts as they may be relevant to aquaculture. FAO offers online references and access to legal texts and to description of legal and institutional context of aquaculture at national levels. Readers are encouraged to visit the following online resources:

FAOLEX is a comprehensive and up-to-date computerized legislative database, one of the world's largest electronic collections of national laws and regulations on food, agriculture and renewable natural resources. FAOLEX is operated by FAO's Legal Office. http://faolex.fao.org/faolex/

ECOLEX is a database providing the most comprehensive, global source of information on environmental law. ECOLEX is operated jointly by FAO, IUCN and UNEP. www.ecolex.org/start.php

National Aquaculture Legal Overviews. The NALOs are a collection of comparative national overviews of aquaculture laws and regulations from the top 40 aquaculture producing countries. These have been prepared by the FAO Aquaculture Management and Conservation Service in collaboration with the FAO Development Law Service. www.fao.org/fishery/nalo/search/en

National Aquaculture Sector Overviews. The NASO collection consists of overviews covering the general aspects of aquaculture and culture-based fisheries at the national level. www.fao.org/fishery/naso/search

However, readers are again invited to consider that these online resources might also need to be checked for most recent relevant documentation.

Finally, readers are invited to consider this Technical Paper in the overall context of FAO's present efforts of contributing technical information and strategic guidance in support of sustainable development of aquaculture worldwide. Major efforts in this context include the development of guidelines on the Ecosystem approach to aquaculture (Soto, Aguilar-Manjarrez and Hishamunda, 2008) as well as other ongoing work on planning and policy development in aquaculture, aquaculture governance, risk analysis, best management practices in aquaculture and certification of aquaculture products (FAO, 2006b; 2006c; 2008c; 2008d; 2008e; Kapetsky and Aguilar-Manjarrez, 2007; Bondad-Reantaso, Arthur and Subasinghe, 2008; GESAMP, 2008).

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PART 1

Reviews and synthesis

Global review and synthesis of reviews of EIA and monitoring in aquaculture in four regions and for salmon aquaculture

Hambrey, J.B.
Hambrey Consulting, Ross-shire, Scotland, United Kingdom of Great Britain and Northern Ireland

Hambrey, J.B. 2009. Global review and synthesis of reviews of EIA and monitoring in aquaculture in four regions and for salmon aquaculture. In FAO. Environmental impact assessment and monitoring in aquaculture. *FAO Fisheries and Aquaculture Technical Paper.* No. 527. Rome, FAO. pp. 3–57.

ABSTRACT

This section offers a summary and overview of the main findings of Phase One of the project "Environmental impact assessment and monitoring in aquaculture", a component of the FAO project "Towards sustainable aquaculture: selected issues and guidelines". It draws on the findings and recommendations from four regional reviews of EIA and monitoring in aquaculture (Africa, Asia-Pacific, Europe and North America, Latin America) and also a special study on EIA and monitoring in the salmon aquaculture industry. The reviews reveal a huge diversity in aquaculture systems, regulatory frameworks and the implementation of EIA and monitoring. Broadly speaking, EIA is only applied to a small proportion of aquaculture globally and, where it is applied, there is rather limited evidence of effectiveness. Monitoring is also limited, and the use of both EIA and monitoring to inform sector management as a whole is rare especially in developing countries. More effective and better targeted EIA and monitoring will depend on better sector management systems, comprising clear environmental objectives and standards (appropriate to both national and local needs), and mechanisms for the management of large numbers of small-scale developments within the capacity of the environment. Monitoring coupled with appropriate feedback mechanisms (to individual farms and the sector as a whole) should be key elements in such a system.

CONTENTS

Acronyms and abbreviations

To improve readability we have sought to minimize the use of acronyms apart from the following relatively widely-used and understood terms

ASEAN	Association of Southeast Asian Nations
BMP	Best Management Practice
CoC	Code of Conduct
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan (associated with an EIA)
FCA	Fisheries Cooperative Association (Japan)
GAP	Good Aquaculture Practice
ICZM	Integrated Coastal Zone Management
SEA	Strategic Environmental Assessment

Summary

This global review and synthesis attempts to summarize the key findings and recommendations associated with four ***Regional Reviews*** of EIA and monitoring in aquaculture, and also a special study on EIA and monitoring in the salmon aquaculture industry ***(Salmon Review).*** These ***Reviews*** have been undertaken in the context of the FAO project component on EIA and monitoring in aquaculture. The ***Reviews*** are detailed and comprehensive, and provide an invaluable resource for learning and inter-country comparison.

The body of this section is structured in line with the terms of reference given for the preparation of all the ***Reviews***, addressing requirements, practice, effectiveness, and improvements, of EIA and monitoring in aquaculture. This summary offers a more cross cutting approach, focussing on some of the key issues and processes associated with EIA and monitoring in aquaculture.

PLANNING AND MANAGEMENT FRAMEWORKS

The wider policy, planning and management framework is critical to the effective implementation of EIA and monitoring in aquaculture. It is impossible to summarize the diversity of these frameworks, but a few examples stand out. In South Australia and New Zealand local marine aquaculture development plans are required, which include aquaculture zones with corresponding objectives, indicators and management response thresholds. These provide a clear framework for licensing and setting conditions or permits for individual farms. They also streamline the environmental assessment process relating to individual farm proposals.

In Japan, Fishery Cooperative Associations are themselves responsible for the management of coastal aquaculture areas, with support from fishery research stations and oversight by prefectural government. They are embarking on a process of so-called Aquaculture Ground Improvement Plans (AGIP) to improve environmental conditions.

More usually the framework is complex, with permits and regulations associated with a range of government departments and agencies. These may relate to disease management, stock movement, water quality, biodiversity, landscape and tourism, product safety, etc. This complexity is a common theme in many of the ***Reviews***, and a source of much frustration to aquaculturists, especially in Europe and the United States of America.

Though there is provision for Strategic Environmental Assessment in many countries (often recommended as an approach to deal with the problem of cumulative impacts) there are few examples of its application. However, less formal versions of SEA are being used in various integrated coastal management initiatives.

A widespread recommendation was for more work on environmental capacity and carrying capacity so that strategic sustainable production plans can be set for particular waterbodies, and licenses/rights issued accordingly.

EIA

The ***Reviews*** make it clear that in many countries it is difficult to separate EIA from environmental regulation more generally. Indeed, the nature of EIA and the way it is applied depends on the wider environmental management framework – and this is as it should be. Unfortunately in some countries with weak environmental management, EIA is seen as a solution – when in reality it is but one tool, and will be ineffective in the absence of other key elements of a management system.

Nonetheless, specific EIA procedures are now very widely established, and EIA is applied to aquaculture in many countries. Clear thresholds or criteria (size, production, type, location) are applied in most cases, and in practice this means that EIA is usually only applied to marine finfish farming in Western countries, and to industrial scale shrimp farming projects throughout the world. It is rarely applied to shellfish farming or small-scale freshwater aquaculture. This means that the bulk of global aquaculture production is not subject to EIA, and alternative approaches to the environmental management of the sector must be applied.

This makes sense. It is clear that individual farm level EIA cannot effectively address many of the key environmental issues associated with large numbers of small-scale aquaculture developments, such as cumulative impacts on waterbody water and sediment quality; introduction of alien species; excessive use of chemicals and antibiotics. Nor does it deal well with inappropriate siting. Nonetheless, for larger scale developments it has played a major role in changing the culture and politics of development, with environmental concerns now high on the agenda when developing project proposals.

Several weaknesses are identified in the ***Reviews***, the most common being lack of consistency in assessment; lack of appropriate standards; lack of integration/coordination between levels and divisions of government; inadequate or inappropriate public consultation; lack of assessment skill and capacity; and excessive bureaucracy and delays in permitting procedures.

A key element in the EIA process is the development of an environmental management plan, including appropriate mitigation measures and monitoring. The extent to which these plans are developed, their quality and degree of implementation appears to vary very widely across the globe, and depends to a great degree on other supporting regulatory measures, and the resources and capacity of regulatory authorities.

EIA has both strengths and weaknesses, and it is important that these are recognised in its application, so that it is not used to address issues which it cannot effectively deal with. Equally the typically large areas of overlap with other regulatory and management measures need to be recognized and rationalized. For example, sector level "good aquaculture practice" guidelines may substitute for large parts of any EIA generated environmental management plan.

Some developed countries with significant aquaculture industries, such as Japan and to a lesser degree the United States of America, do not apply EIA as such (i.e. as an identifiable separate legal procedure), but nonetheless have rigorous licensing and permitting regimes which require different forms of environmental assessment.

MONITORING

Monitoring data may be collected:

- as part of an EIA generated Environmental Management Plan (EMP);
- in compliance with some form of code of practice;
- for the information of the farmer in support of husbandry;
- by regulatory authorities as part of enforcement;
- by regulatory authorities as part of monitoring in wider environment.

Many weaknesses were identified in the ***Reviews***. The main one was lack of follow through of monitoring requirements as developed in the environmental management plans – in terms of analysis, reporting and feedback – into management of individual farms and the sector as a whole. With regard to monitoring in the wider environment (usually undertaken by government) the main problems relate to the ambition and scope of much monitoring and the lack of capacity to analyze, report and use this data to improve management of the sector as a whole. A common recommendation was to use risk analysis to identify priority issues for which monitoring was required, and to focus on the most important parameters.

DECISION-MAKING

Decision-making did not figure explicitly in most of the ***Reviews***, but was a common underlying theme reflecting issues such as: inconsistency; lack of transparency; subjectivity. This is an important issue worthy of more attention. While some of these problems can be addressed through drawing up of standards, criteria, thresholds and so on, there will remain a need to make trade-off decisions which will include highly subjective socio-cultural dimensions, including tradition, community, landscape and so on. There is huge variation in the way these issues are addressed (e.g. by politicians, committees, commissioners, facilitators, ad hoc panels, etc.) and much experience to draw on.

MANAGEMENT SYSTEMS

Amongst the various weaknesses highlighted in the ***Reviews*** three in particular stand out:

- The difficulty of addressing cumulative impacts of many small-scale developments through conventional EIA.
- The lack of environmental objectives and standards – especially those suited to the local context.
- The lack of analysis and feedback of monitoring data into sector management.

These are all indicative of a tendency for government and regulatory authorities to focus on particular techniques (such as EIA) and individual farms rather than on a management system for the sector. Equally the emphasis on monitoring at farm level needs to be balanced with emphasis on environmental management systems which can make use of this information.

The components and tools used in such management systems would vary according to development context and the nature of aquaculture development. The key elements are however simple:

1) understand the values of the natural resource system (which underpins aquaculture and other activities);
2) set objectives, indicators and response/management thresholds to maintain or enhance these values;
3) agree on mechanisms and means by which to meet the objectives (farm and sector level mitigation);
4) monitor performance in terms of achieving objectives;
5) make corrections to the mechanisms if necessary to meet objectives.

Some countries are beginning to recognize this, but much remains to be done. The emphasis on EIA and monitoring only may well have been a distraction. EIA and monitoring are *specific tools* for environmental management, which, in the absence of an overall and effective management system, simply become bureaucratic exercises.

This emphasis on understanding natural systems, and building corresponding management systems is in line with the principles for an “ecosystem approach to aquaculture” being developed through another component of this project (Soto, Aguilar-Manjarrez and Hishamunda, 2008).

Introduction and background

This section offers a summary and overview of the main findings of Phase One of the project "Environmental Impact Assessment and Monitoring in Aquaculture", a component of the FAO project "Towards sustainable aquaculture: selected issues and guidelines". Phase One of this project supported the preparation of four regional case studies which reviewed existing EIA and environmental monitoring procedures and practices in aquaculture in selected countries of the following four composite regions.

Africa:	Egypt, Madagascar, Nigeria, South Africa, Tanzania, Uganda;
Asia-Pacific:	Australia, China, India, Indonesia, Japan, Malaysia, Philippines, Thailand, Viet Nam;
Europe/North America:	Czech Republic, France, Greece, Hungary, Italy, Netherlands, Poland, Spain, Turkey, United Kingdom, as well as Canada and the United States of America;
Latin America:	Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico.

A fifth special case study focused on EIA and monitoring in marine cage aquaculture of salmon in Canada, Chile, Ireland, New Zealand, Norway, the United Kingdom and the United States of America. A case study on small-scale cage culture in Bolinao Bay in the Philippines was also prepared for the technical workshop (see Part 2 of this publication).

This section seeks to draw together the main findings of these comprehensive and detailed reviews. The great diversity of aquaculture systems, geography and economic context made this a daunting task, and this review cannot do justice to the breadth of information and experience assimilated by the various authors. This section therefore also seeks to signpost wherever possible specific examples, so that readers can explore particular issues in more detail by reference to the individual review documents.

Where a particular country is referred to, the source of information will be the corresponding regional review unless otherwise stated. Where the source is the salmon special case study, this is explicitly referred to in order to avoid confusion with the corresponding regional review.

Where the reviews are referred to in the text, the following abbreviations are used:

Africa Review. Review of EIA and monitoring in aquaculture in Africa

AP Review. Review of EIA and monitoring in aquaculture in the Asia-Pacific Region

ENA Review. Review of EIA and monitoring in aquaculture in Europe and North America

LA Review. Review of EIA and monitoring in aquaculture in Latin America

Salmon Review. Review of EIA and monitoring in salmon aquaculture

The Reviews. General reference to all the review papers

Country Reviews. This refers to the subsidiary country reviews which are presented within the regional reviews and salmon review

Bolinao Bay Case: EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay, Philippines: a case study

The main part of this synthesis is structured broadly in line with that used in the above ***Reviews***, addressing in turn requirements, practice and experience, effectiveness and suggested improvements EIA and monitoring in aquaculture. There is inevitably some duplication and overlap between the sections on requirements and practice. The executive summary has been structured somewhat differently in order to rationalize the overlap between these sections, and in order to draw out some key issues.

Legislation and requirements

INTRODUCTION

The environmental management of natural resources, and water resources in particular, has increased in importance throughout the world in recent years, and comprehensive frameworks now exist in many countries. Indeed, in several countries (Nigeria, Philippines, South Africa) environmental protection and sustainable natural resource management are enshrined in the constitution.

Much of the environmental legislation has been put in place since the 1970s (Japan, Philippines, United States of America), the 1980s (China, Hong Kong SAR, Indonesia, Republic of Korea, and Western Europe) and the 1990s (much of Africa, Latin America and Southeast Asia). Many countries make specific regulatory provision for aquaculture, usually with an environmental management dimension, although this may come under different ministries and/or umbrella legislation, including agriculture, fisheries, water resources management (including irrigation), land use, environmental protection. There is very wide variation in the degree and complexity of environmental regulation and management. In many countries the legal framework is complex, with a wide range of ministries, agencies, and different levels of government having a range of responsibilities relating to aquaculture.

In Egypt, for example, environmental management of aquaculture takes place primarily within the well established legal framework relating to irrigation. In Japan there are highly developed procedures for the management of fisheries and aquaculture in coastal waters through user organizations. In Spain, freshwater aquaculture is highly controlled under laws relating to water supply and use. South Africa has new and comprehensive legislation covering environmental management frameworks, strategic environmental assessment, EIA, and more specific requirements for particular activities.

In some countries where aquaculture has developed rapidly over the last two to three decades there has been a tendency to develop aquaculture-specific legislation, including provision for environmental management. Thus Mexico and Norway for example have both passed aquaculture specific legislation in recent years with the primary objective of promoting sustainable aquaculture development. While not necessarily reducing the complexity of environmental management procedures, this does at least ensure that the procedures are appropriate to aquaculture, or “fit for purpose”.

The most complex and restrictive regulation and management tends to apply to intensive marine finfish farming, mainly because this is a relatively new and rapidly growing industry in many countries, and because the marine environment is often regarded as relatively pristine.

In just a few countries there is very little legislation for the environmental management of aquaculture. This applies for example in some of the Eastern European countries where extensive pond rearing of carp is a traditional activity which has been practiced for up to thousand years, and which has never been regarded as a threat to the environment (Hambrey, Edwards and Belton, 2008). Indeed it is widely regarded as an example of sustainable husbandry. In some Eastern European countries extensive pond culture is regarded as making a significant contribution to biodiversity, and some ponds have been designated as nature reserves. The situation may change if culture practices become more intensive. At the other extreme, some countries (e.g. Madagascar, Norway) have a specific aquaculture law.

BOX 1
Legislation typically serves as the framework for regulation relating to:

- Conversion or use of a site
- Destruction/modification of habitat
- Abstraction/use of water
- Use of drugs and chemicals
- Discharge of waste (food, fecal materials, dissolved nutrients, chemicals, drugs)
- Monitoring of water quality on the farm, and in the wider environment
- Import/rearing of alien species/GMO
- Movement of stock, and control of disease (biosecurity)
- Reporting and treatment of disease
- Food safety/quality (chemical residues and bacteria)

The complexity of most legal frameworks, and overlapping responsibility between different ministries, agencies, and levels of government, is raised in several of the *Reviews,* and in particular that relating to Europe and North America. In some countries this problem has been recognized, and some rationalization achieved through sector specific framework legislation (i.e. an aquaculture Act). These laws usually have the overall objective of promoting responsible and sustainable aquaculture development. However, the use of coastal or common access freshwater resources will always impinge on a wide range of rights and interests, and the legislation is bound to be fairly complex.

In most countries the legal framework is implemented through some form of licensing or permitting procedure, supplemented with powers to control or manage some or all the issues listed in Box 1. Some form of application and assessment process is typically required in order to gain a licence and any associated permits, and this may or may not include a requirement to undertake EIA. In several Latin American countries a specific *environmental licence* is required.

In practice, in many countries the small-scale and/or traditional nature of aquaculture means that most aquaculture operates outside the relatively new legal frameworks.

Japan offers a very different model. Broadly speaking the emphasis in the regulatory framework is on *the protection of aquaculture from other threats*, such as sewage and industrial effluents, rather than managing the threats from aquaculture. Although there is legal provision for aquaculture EIA in Japan – usually for larger projects but depending on the Prefecture – the main mechanism for environmental management of aquaculture is delegated and assigned to Fisheries Cooperative Associations (FCAs). Fisheries rights – including those to practice aquaculture - are granted by the Prefecture governor to an FCA. FCAs then become responsible for management and evaluation, including environmental assessment, monitoring, and putting in place appropriate local regulations, which in turn are authorized by Prefectural government. These procedures were strengthened in 1999 with the Law to "ensure sustainable aquaculture production" which addresses in particular disease, and environmental conditions. This requires FCAs to implement "aquaculture ground improvement plans".

Many countries have fairly comprehensive requirements. South Africa for example has new regulations covering environmental management frameworks, Strategic Environmental Assessment (SEA), EIA, and more specific requirements for associated risk assessments and environmental management plans.

PERMITTING AND LICENSING PROCEDURES

Nearly all countries now have in place some form of licensing and permitting procedure for aquaculture. Licences are usually conditional – in relation to production rates and/

or practices – and may be dependent on obtaining a set of more specific permits relating to land use, water use, the farming of particular organisms (especially introduced species), health and disease, waste discharge, etc. Some countries (e.g. Brazil, Ecuador) require a specific "environmental licence" which may address several of these issues.

Most countries require a basic technical proposal detailing the nature of the farm, and in some cases a simple "environmental statement". Other countries require a more detailed environmental assessment (though these vary tremendously in scope and detail[1]), especially for larger scale developments, as part of the permitting and licensing procedure (see below). In a few cases the licence and associated permits are more closely tailored to the needs of a wider environmental management plan for the sector or for a particular area or zone.

Licensing procedures generally serve as the key to environmental management of the industry. There is significant variation in the strengths of these procedures, the extent to which licenses or permits are conditional, and the scope and complexity of the conditions that may be applied. It is clear that a "one-off" permit is of little value in terms of the management of the aquaculture sector. To have value there must be an ongoing framework to ensure that any conditions or mitigation measures are adhered to, and where there is uncertainty about possible impacts, provision for monitoring. In general, while the requirements for licences are usually clearly laid down in the legislation and associated regulation, requirements for enforcement, monitoring, reporting, and feedback into the management of the sector are often limited and weak.

The duration of the license is a key issue. In Scotland (United Kingdom) a permit for marine finfish farming used to last for 15 years, but has now been made indefinite. In China a lease or permit to undertake aquaculture is issued for a 15-year period. In India, following a groundbreaking Supreme Court judgment in 1996, a licence is required for semi-intensive or intensive shrimp farming from the Coastal Aquaculture Authority, which is valid for only five years. The duration of a permit has significant implications for investment and is discussed further below.

In some countries licensing is a staged process. In Brazil for example there is a 3-stage process with a requirement for a preliminary license (approved concept and location); an installation license (authorizing the preparation and installation); and an operation license. The latter two licences are subject to an agreed "environmental control plan" and "environmental monitoring plan". In Honduras a preliminary environmental license is issued for one year only – to ensure that all mitigation actions stipulated in the document of approval are complied with. After this period, if conditions are satisfied, the environmental licence is renewed indefinitely, but the project is subject to regular inspection.

REQUIREMENT FOR EIA

Most countries now have specific legislation relating to EIA. Most of this has been developed since its introduction to the United States of America back in the 1970s. Over the last decade or so it has been introduced to many developing countries, including widespread adoption in Africa, where 75 percent of countries have specific EIA legislation of which 50 percent has been introduced in the last 5 years. In many cases this is "mirror" legislation, introduced in part in response to pressure from more developed countries, international agencies and development banks, and often based on legislation from western countries.

In some countries aquaculture is specifically referred to in the EIA legislation (e.g. Cuba, the Philippines); in others aquaculture comes within a category where

[1] There is a spectrum of environmental assessments and corresponding terms ranging from simple environmental statements or declarations written by the applicant, through "initial EIA", "preliminary assessment", "basic assessment", specific requirements relating to the content of a "project brief", to full blown independent professional EIAs including public consultation.

EIA may or may not be required, according to its type and scale, the quality and status of the local environment, and the judgment of local officials. In most countries EIA is required for activities or projects "*likely to have a significant impact on the environment*". Countries may have indicative lists of projects or activities deemed to meet this criterion.

In less developed countries (for example, most African countries) or those where small-scale aquaculture is well established, EIA is typically applicable only to major projects, and the relatively few examples applied to aquaculture have been called for by investors or aid agencies. Most aquaculture is perceived as small-scale and low risk – and the priority is on development rather than environmental protection.

Many countries have procedures which may not be formally labelled as EIA, but which have many similar characteristics or serve related functions. In Sabah, Malaysia new aquaculture over 10 ha requires a "*mitigation measures report*". In Victoria, Australia a formal EIA is not generally required, but a proposer is required to provide specific information to all permitting organizations: water authority; catchment management authority; environmental protection agency; local authority. Taken together this information amounts to a form of EIA.

Of particular significance to this review, several of the worlds' major aquaculture producers, including China, Japan, Thailand and some states in the United States of America, do not have a specific requirement for EIA in relation to aquaculture development, irrespective of scale. These countries rely variously on planning, clear standards and associated regulation, codes of practice, and monitoring. Algeria specifically excludes aquaculture from EIA regulations, in favour of specific tailored regulations.

Screening

The decision as to whether EIA is required, and at what level of detail, is often formalized in a process referred to as *screening*. This is meant to ensure that EIA is only applied where necessary, and is usually based on some form of environmental risk assessment - though this may not be referred to as such, and is rarely rigorous.

In many countries, aquaculture development requires EIA if it meets certain thresholds in terms of area, production or water use. In Asia for example these thresholds typically vary between 10 and 50 ha, although there may be differing provision for pond and cage farms, and for freshwater or marine. In most cases the practical effect of this is to include most significant intensive marine *finfish* developments, and to exclude small-scale and extensive production, shellfish farming, and most farming in freshwaters. The EU guidance (European Commission, 2001) notes the need to apply screening with care so as not to undermine smaller and more routine projects.

Some countries have lists of activities for which differing approaches are required. Thus Egypt has three lists: black, white and grey. Aquaculture is in the grey list, meaning that EIA *may* be required. However, if it is to be sited in an environmentally sensitive area, it becomes a "black list" activity and automatically requires full EIA. In Nigeria EIA is required if close to coral reef, mangrove swamps or wetlands, or if it involves significant drainage and irrigation. Similar provisions apply in Latin American countries such as Mexico, where EIA is required, for example, in mangrove areas, or in fish recruitment and nursery areas – although the final decision rests on the judgment of a local official following a site visit. In Ecuador, EIA is specifically required for aquaculture that makes use of groundwater in the highlands.

There is often a requirement for different levels or kinds of EIA according to the nature and scale of the enterprise. Thus in India farms above 10 ha require a relatively simple environmental impact statement (EIS) and details of environmental management and monitoring. Above 40 ha, a full EIA and environmental monitoring and management plan is required. In Mexico projects of more than 500 ha require a "regional" as opposed to a "particular" EIA. In many countries proposals are vetted by the authorities and categorized in terms of their potential impact or environmental risk (e.g. Brazil, Honduras). Criteria may include size, location (sensitive areas), other users, technology, etc. Different levels of environmental assessment and control are required for the different categories. These may range from a requirement to agree to abide by the standard regulations, a requirement to make an environmental statement or declaration, through to full blown EIA.

Specific issues may also be used to trigger EIA for aquaculture. Thus in Madagascar and United Republic of Tanzania any plans to introduce an alien species or genetically modified organism automatically triggers EIA.

Some countries require EIA not only when a farm is established, but also if it seeks to expand (e.g. United Kingdom). Depending on the country and the scale of proposed developments, this may or may not be a full blown EIA (e.g. Mexico).

Responsibilities

EIA is usually paid for by the developer, carried out by third parties, and appraised by government experts or expert/stakeholder panels. Final decisions relating to EIA are usually the responsibility of either the environment agency or the sectoral (e.g. fisheries) agency, although in some countries local government plays a major role.

There is a general tendency in Asia toward decentralization of responsibility, and this applies to procedures such as EIA. In the United States of America the situation is complex with many agencies and departments at federal and state level. In Scotland there has been a recent shift in responsibility for permitting of aquaculture to local government, although environmental management remains the responsibility of a national agency.

These issues are dealt with in more detail in the discussion of practice below.

EIA procedures

EIA legislation is usually supported with guidance documents setting out the types of issue to be addressed in EIA. In some countries and regions there are specific guidelines – often detailed – for EIA, and in some cases detailed guidance specifically in respect of EIA for aquaculture (e.g. South Africa, United Kingdom, see also the ***Regional Reviews*** and the ***Salmon Review***). Most countries however follow a fairly standard procedure:

1) **screening** (is EIA required/what level is required?);
2) **scoping** (what issues should be addressed and how - this serves as the basis for terms of reference for the assessment);
3) **assessment**;
4) identification of **mitigation** measures (usually in the form of an environmental management plan or EMP);
5) **reporting**;
6) **evaluation**/appraisal;
7) **decision-making** and conditional permitting.

Screening is usually fairly standard and based on criteria set down in legislation, although in some countries is left up to local officials (see above section on Screening).

Scoping allows for initial consultations with agencies, government – and in some cases other stakeholders – to inform or define the scope and detail of any environmental assessment. The ***ENA Review*** notes that this process can however allow for the focus of the assessment to be "high-jacked" in favour of a particular agenda, and that more generic guidance on scope would ensure greater consistency and neutrality.

Typically however EIA will address all the major environmental issues associated with aquaculture as listed in Box 1, including direct, indirect, local and wider effects on water and sediment quality, ecology, other resource user interests and human wellbeing more generally.

Inclusion of effects on landscapes is more variable, but tends to be more significant in developed countries and locations with a significant tourism sector, such as Spain, Scotland and Canada. Indeed, in Scotland landscape has become an increasingly important element in EIA, since many of the other issues (such as impacts on water quality) are effectively dealt with under standard environmental management regulations.

Socio-economic impacts tend to receive rather limited attention in the requirements for impact assessment. To some degree this is because it is assumed that such issues will be taken into account elsewhere in the decision-making processes, especially where these include significant public involvement. There are exceptions however – EIA in Egypt places strong emphasis on assessing impacts on other resource users.

Clearly the potential scope of an EIA is huge, and boundaries difficult to draw. The usual scoping may not help much, if a full range of stakeholder interests is included in the process. Increasingly there is recognition of the need to use a more formal "risk" based approach to both screening and scoping – concentrating on those issues deemed to present the greatest risk of serious impact.

Many modern guidelines emphasize the need to address ecosystem functions and services, but experience of this is limited.

Assessing the **significance** of any identified impacts lies at the heart of EIA, yet it is difficult to legislate specific requirements. The quality of the process depends crucially on the skill, knowledge and impartiality of the consultant. Some countries, such as Malaysia, require that EIA consultants are certified by government, but this is far from universal.

Significance of identified impacts can however be measured in two important ways: through comparison with international, national or local standards; and through stakeholder or wider public consultation. Many countries have specific requirements in relation to these.

Most countries have **water quality standards**, which may apply to:

- particular waterbodies;
- particular types of waterbody;
- particular uses;
- particular zones.

In some countries objectives and standards have been or are being developed for particular locations and use zones, taking full account of local ecology, local values, and local uses as part of local integrated coastal or river basin planning (e.g. South Australia; Tasmania; New Zealand, parts of Europe). This ensures that there is an objective reference framework of objectives, values and standards against which to assess significance and/or acceptability of any impacts. This is a key requirement for effective management irrespective of whether formal EIA is required.

Norway has recently developed a set of standards relating to aquaculture installations – the "Nytec" standards (***Salmon Review***). Depending on exposure and hydrodynamics certain minimum standards for e.g. cage strength and construction must be met. These standards are independently audited and installations certified accordingly. They are intended as part of a wider strategy to minimize escapes. This is a particular example of streamlining the permitting process by standardizing mitigation measures for all installations, which would otherwise have to be established through individual EIA and associated environmental management plans.

In Japan, the Fishery Resources Conservation Association establishes environmental quality standards specifically for aquaculture grounds, and associated guidance for the development of area wide environmental management plans. These relate mainly to acceptable levels of dissolved oxygen (DO), chemical oxygen demand (COD), and acid volatile sulphides (AVS). These are supplemented with further sets of standards relating to water quality under the basic environmental law. Some of these are linked to health hazards and shellfish standards.

Standard **modelling** of organic matter deposition and nutrient or chemical dispersal is a routine requirement in some countries such as Norway and Scotland, and is increasingly being explored as a tool in other countries such as China and Japan. This again is a way of standardizing and formalizing what would otherwise be a part of EIA and making it a standard regulatory requirement in order to gain the appropriate discharge permits.

Public participation is often a specific requirement in EIA legislation and almost universal in guidance materials. Under Malaysian federal law for example, public participation in the EIA process is required. Usually, this is to allow for rapid identification of key resource use issues so that they can be addressed and/or defused. It also allows the farmer to draw on existing local knowledge. The extent and nature of such consultation, and the manner in which views expressed should be reported and analysed is rarely specified. There are exceptions to this however, with relatively strong and specific requirements in some African and Latin American countries for example. In Zanzibar a mechanism is provided for out of court settlements of environmental disputes – special mediators, trained in dispute resolution and acceptable to all parties can be appointed.

Environmental Impact Statements (EIS) – the reports associated with an EIA process – are also usually required to be publicly available. However, it is notable that the review teams for this present project generally found it difficult or impossible to recover specific examples of Environmental Impact Statements in many countries, especially in Asia and Europe. There are exceptions however – in Malaysia most EIA reports are available on the Web site of the Department of Environment. In countries where aquaculture planning and zoning is required, such as Australia and New Zealand, public consultation is a specific requirement in the identification of aquaculture zones.

Much EIA legislation sets down a specific requirement that EIA result in both an EIS and an "**environmental management plan**" (EMP), in which the mitigation measures to be implemented, along with monitoring, reporting and management feedback mechanisms are described (e.g. South Africa). In some cases the EMP may be incorporated in the licensing or permitting conditions for the farm.

MONITORING AND REPORTING

In most countries there is rather limited requirement for monitoring the environment in the vicinity of aquaculture operations. Most EIA will however identify some monitoring needs. In many cases the legislation to enforce such monitoring and/or its reporting is weak. There is limited coupling between EIA monitoring recommendations and wider environmental monitoring schemes.

Some countries do however make clear and specific provision for monitoring. In Ecuador for example the law requires that projects that have been subject to EIA, or have been granted an environmental license, are to be selected at random for periodic inspection so that if needed corrective measures can be introduced in a timely manner.

Most countries have wider government funded and executed environmental monitoring schemes for coastal and freshwaters. China, Japan, Viet Nam all have such schemes specifically related to aquaculture, and these include monitoring of disease as well as environmental parameters. Countries for which shellfish farming is important also tend to have well developed environmental monitoring schemes, mainly designed to protect human health. In the European Union comprehensive monitoring of the aquatic environment (divided into "waterbodies") is required under the Water Framework Directive (European Commission, 2000). Monitoring specifically in relation to aquaculture will be required where aquaculture is identified as a possible threat to the quality status of the waterbody.

Responsibility for monitoring varies widely. In many developed countries with a significant aquaculture industry (e.g. Australia, Chile, Norway, Scotland) finfish farmers are required to undertake certain forms of monitoring and reporting related to sediment and local water quality, while government authorities undertake additional monitoring related to particular farms and/or the wider waterbody. In Australia, the discharge consent license requires farmers to undertake basic monitoring and reporting against environmental management objectives, and also to present an annual report to the Environmental Protection Agency (EPA), including mass balance in terms of nitrogen and phosphorus, analysis of data, etc.

In India requirements for monitoring are ***issues-based*** rather than prescriptive: impact on water sources; on ground water quality; on drinking water sources; on agricultural activity; on soil and salinization; effectiveness of water treatment; effect on green belt. No detailed guidelines are offered as yet.

ROUTINE REGULATION

Irrespective of licensing, EIA or sector planning initiatives, many countries have well established legislation and regulation to control and manage pollution and waste discharges from industrial activities. This has been extended to agriculture in recent decades, and many countries now apply controls to aquaculture – especially the more intensive production systems. In those cases where EIA is required, the EIA will address the extent to which the farm is expected to be compliant with these standard controls; in a few cases the EIA may inform the nature or level of license specific consents.

Regulation may apply to the following activities and issues:

- abstraction of water;
- land use activity;
- use of chemicals and drugs;
- use of/quality of other inputs (e.g. food);
- discharge of nutrients (typically N, P);
- discharge or organic matter (carbon or suspended solids);
- discharge of chemicals and drugs;
- import and movement of stock and eggs;
- introduction of alien species;
- disposal of mortalities;
- use of genetically modified organisms;
- product quality: chemical residues; bacteria.

Specific permits or certificates may be required for some or all of these, and typically some form of assessment is required in order to gain a permit or certificate for each. In practice therefore obtaining the various permits may correspond to – or substitute for – EIA. It is false therefore to assume that because a country (such as Japan, Thailand, parts of the United States of America) usually does not require EIA for aquaculture, its aquaculture management regime is less comprehensive or effective. Indeed, the contrary may be true: a well developed and implemented regulatory regime addressing all the key impacts of aquaculture may be more effective than "one-off" EIA.

Breach of a permit, or undertaking an activity without a permit, may be sanctioned through fines, restrictions, loss of license and closure. In India for example, the Coastal Aquaculture Authority can close down any farm which it considers to be causing pollution.

Regulation may be less specific and more tailored to local circumstances. In inland waters of Australia for example, farmers must ensure that their operations do not compromise "beneficial uses". These are defined for particular segments of waterways, and in practice usually relate to nutrients, pathogens, and aquatic pests. This represents a move towards an "ecosystem service" approach to management. The protection of other stakeholders is often a key issue for regulation. In Cuba for example semi-intensive and intensive breeding of fish is not allowed in reservoirs used for human consumption. In China local fishery administrations have significant authority to generate regional regulations for aquaculture – tailored to local conditions and regional development plans – especially since disease and environmental degradation has become a more serious problem.

STRATEGIC ENVIRONMENTAL ASSESSMENT AND PLANNING

Even though provisions for SEA exist in many countries, there are few examples of its application. However, less formal versions of SEA are being pursued in various initiatives. The ***Reviews*** confirm that in recent years several countries have introduced requirements for SEA, including China, Hong Kong SAR, European Union countries, Republic of Korea and Viet Nam, and there is widespread interest in the development of area management plans for aquaculture.

In South Australia, Tasmania and New Zealand there is a statutory requirement for coastal plans and/or marine aquaculture planning, including the use of environmental assessment to identify areas suitable for aquaculture, and to develop local environmental objectives and standards. As part of these, environmental capacity must be addressed, and in this sense a form of SEA is being undertaken as an integral part of coastal planning. Similar exercises have been undertaken in Scotland, but only as pilot exercises to date. Aquaculture development zones are also being developed in South Africa and are seen as tool to minimize conflict and reduce risk and uncertainty associated with EIA outcomes. These are described as "ready to invest sites".

Under Mexico's recently introduced General Law for Sustainable Fisheries and Aquaculture, aquaculture management plans are to be developed for cohesive regions (species, systems, geography) which take account of regional economic development plans, ICZM and other relevant plans; which address carrying capacity of major waterbodies; which are developed on the basis of participation and inclusion; and which include infrastructure, environmental protection measures and sanitary issues. These plans are intended to set the framework and context for permitting procedures. This law does not appear to require SEA as the basis for the development of the plans, although any planning approach which addresses carrying capacity has much in common with SEA.

In China, individual states are responsible for drawing up plans for the use of water surface areas, and for defining areas suitable for aquaculture. Zoning is required under the Law on Coastal Areas. These plans must include specific provision to avoid/protect spawning, feeding, breeding and migrating areas. Aquaculture developers must apply for a license from the fisheries administration at or above county level in order to use these areas. The license may be withdrawn if a given area is not used within 12 months. Environmental assessment is now required for *special programmes* under a law introduced in 2002, and this applies to aquaculture programmes. This is supported by a new "planning environmental assessment" regulation.

In the European Union, SEA is required for development "plans or programmes" and this should include those related to aquaculture. For example, in Scotland an SEA was required for a government supported "farm relocation programme" (Scottish Executive, 2007). In India planning and management guidelines have been issued by the Coastal Aquaculture Authority. Planning is to be undertaken within the context of basin wide planning of state water resources. In Egypt aquaculture is rarely subject to EIA but is tightly controlled and managed under more traditional laws and plans relating to land and water use.

In Japan, aquaculture ground improvement plans (AGIP) must be drawn up by fishery cooperative associations, with approval from prefectural government required. These may include voluntary agreements on production, monitoring, sediments, etc.

The detailed procedures amount to a form of adaptive management, with monitoring feeding back into management initiatives.

Many other countries (e.g. Brazil) are in the process of introducing procedures for the development of regional or local area plans for aquaculture development, or intend to bring aquaculture within a broader coastal planning and management framework (e.g. many European countries).

CODES OF PRACTICE

Codes of conduct, codes of practice, best management practices, good aquaculture practice and a host of similar initiatives under a variety of names are becoming widespread across all regions, and seen as a means to reduce the regulatory burden on government and encourage self regulation within the sector (Tucker, Hargreaves and Boyd, 2008) . While not legally required in most countries, there may be links with regulation.

In Indonesia, Philippines and the United States of America, for example, adherence to Best Management Practice (BMP) may be a requirement for gaining a license or permit. The BMP serves a standard substitute for the "mitigation measures" or environmental management plan which might otherwise be identified in an EIA. In the United Kingdom the development of a widely-adopted Code of Conduct (CoC) for finfish farming was seen as a way to reduce the need for further regulation. In a sense however the CoC was only partly voluntary: without it more regulation would probably have been introduced.

STATE OF INDUSTRY REPORTING

Authorities in many countries compile data on the location and extent of aquaculture operations, although this is less readily done in those countries where aquaculture is small-scale and widespread, as in many parts of Asia. Authorities in some countries report in some detail on the status and performance of the industry. For example, under the recently introduced General Law for Sustainable Fisheries and Aquaculture, Mexico requires production of an annually revised comprehensive, technical and geographic "aquaculture chart" which includes information on species and culture systems, zoning and development potential, environmental regulation and sanitary/ food safety issues. In Norway and the United Kingdom annual state of industry reports are published on basic locational, production, employment and economic performance.

SUMMARY

The legislation and requirements relating to the environmental management of aquaculture are detailed and demanding in many countries, especially in relation to gaining a license or permit to farm fish above certain size or production thresholds. This is especially the case for marine finfish farming and large scale shrimp farming. EIA may or may not be part of the requirement for establishing a farm; but in practice most of the issues dealt with in EIA can be, and often are dealt with through a series of permitting procedures relating to specific environmental management issues. In some cases these procedures substitute for EIA, in others they overlap and duplicate to some degree. The complexity and scope of EIA is such that there is increasing recognition of the need for effective risk assessment as part of the screening and scoping processes.

The requirement for public consultation, and the required nature of such consultations in EIA remains very varied across the globe. The requirement to consider landscape is also rarely spelt out, though it is becoming more important in developed countries and those with major tourism industries.

Legislation relating to the environmental management of ongoing operations is typically weak in many countries, especially those that rely on EIA as the main tool for environmental management. Requirements to audit and monitor implementation of EMPs arising from EIA for example, are often extremely limited. Environmental objectives and standards, and more comprehensive codes of conduct have become key tools in the environmental management of aquaculture and can strengthen or partially substitute for EIA. More comprehensive area natural resource management plans, marine, coastal or river basin plans or aquaculture plans are less widespread, but have become key tools in a few countries, including several with major aquaculture industries. These allow for the establishment of more locally appropriate procedures and standards.

While traditionally the requirement for better environmental management has come from government, there is increasing pressure from the market – especially the export market – for demonstrated environmental management credentials. Codes of conduct coupled with certification schemes are being adopted more widely, and in some countries this is seen as an opportunity to reduce the government imposed regulatory burden.

Practice and experience

There is significant legislation relating to the environmental management of aquaculture including EIA. For EIA itself there are relatively standard procedures, with much guidance and training, but rather limited application in many of the less developed countries.

In practice EIA as such is only applied to large scale aquaculture projects, irrespective of legislative requirements – typically large scale shrimp projects or medium-large scale marine finfish. The vast majority of aquaculture activity throughout the world is unaffected by EIA legislation, and this situation is unlikely to change. It is simply not feasible (and arguably pointless) to apply this procedure to the very large numbers of small-scale fish farms which dominate aquaculture production globally. Smaller farms are however increasingly subject to conditional licensing and good aquaculture practice (GAP) requirements, typically implemented through sectoral departments or agencies.

POLITICAL CONTEXT

There are substantial differences between countries in terms of the political priority afforded the environment, and this in turn influences the relative power of the various institutions involved – and especially the balance between environmental precaution and economic development. Broadly speaking greater weight is afforded environmental concerns in the developed western countries as compared with eastern and less developed countries. However there are significant regional variations. In Africa for example environment is well up the political agenda in Uganda and Ghana. In South Africa the "right to a healthy environment" and "sustainable development" are both enshrined in the new constitution. In Nigeria environmental protection is also enshrined in the constitution. In other countries it may be seen as bureaucratic and constraining.

INSTITUTIONS

One of the key issues in relation to any EIA system is where ultimate responsibility for EIA and any related permit/license/concession is vested. This is highly variable – indeed, no two countries are exactly alike. Many of the ***Country Reviews*** note the institutional complexity related to the management of aquaculture. Aquaculture tends to come between a range of sectoral ministries or agencies – agriculture, fisheries, water resources, rural development, etc. – and this makes the implementation of any management legislation complex and bureaucratic, especially when there are substantial subjective elements involved. The situation is further complicated by the need to take both national and local interests into account. In Brazil for example each state can propose their own criteria for environmental licensing – provided it is not more permissive that the federal regulations.

The environmental licensing or EIA process may be managed/coordinated by:

- a national environment or natural resources department or agency;
- "biosafety" agency;
- a national fisheries/aquaculture department;
- a national administration department;
- a state level governors office;
- a local government environment, natural resources or fisheries department;
- a local government planning department.

In many countries a range of other institutions and committees may be involved in advising, or in issuing appropriate permits – relating to siting, operation, discharges, medicines and so on. In Europe and North America in particular these procedures tend to be very complex and can result in long delays (often up to two years) in getting a farm established. This is usually more complex in respect of coastal and marine aquaculture.

The number and nature of institutions involved in a permitting process, and the way in which EIA is used as part of this process is therefore almost infinitely variable – both within and between countries. What is clear however is that in most cases the situation is complex, and often the cause of much frustration to aquaculturists. Even where there have been concerted attempts to simplify and rationalize procedures these have had limited impact: the issues are complex; the number of stakeholders and perspectives are large.

It is reported in several of the ***Reviews*** that links between the sectoral departments and environmental agencies/departments are often weak and lacking clarity. Some countries have made specific efforts to address this problem. Thus Ecuador has a "National Decentralized System of Environmental Management". This system constitutes a trans-sector coordination, integration and cooperation mechanism among the different institutions dealing with environmental and natural resource management. Honduras has a "National Environmental Impact Assessment and Evaluation System" which also seeks to coordinate and integrate the many different institutions and interests. In Uganda environmental officers and environmental liaison units have been established within the sectoral agencies or departments. China also offers an interesting example of significant integration between a strong national Environmental Protection Agency which is forced to integrate with local government at provincial and lower levels – since it often depends on it for funding.

There has been a recent tendency to give more responsibility to sectoral agencies for the environmental management of the sector. This applies for example in Norway, and a recent review of procedures in Viet Nam led to greater role for the sectoral agency in environmental management. However, responsibility for EIA itself is commonly assigned to a national environmental agency or its regional offices, although there are exceptions. In the United Kingdom for example, local government is now designated as the responsible authority for EIA, though using guidelines and templates developed by national government working with environmental agencies. Japan offers a simpler and substantially different model where producer organizations themselves are responsible for the management of coastal areas for fisheries and aquaculture – although they in turn are answerable to the prefectural government. Groups of operators can apply for a demarcated fishery right.

It is likely that where producer organizations or fisheries departments have a more powerful role, the situation will be more favorable for fish farm development. Broadly speaking sectoral departments or agencies (fisheries, agriculture, rural development, etc.) are more powerful than environment agencies in the less developed economies, while there is a more equal balance in more developed countries. In many cases however, the sectoral agencies are themselves required to take a major role in environmental management. This again has both strengths and weaknesses – it ensures a much closer integration of environmental and production interests, but it may weaken the rigor of environmental management.

A "one stop shop" – or single point of contact for the farmer – is often proposed as a mechanism to rationalize assessment and other regulatory procedures associated with aquaculture development. However, it is unclear that this will reduce complexity much, given the range of regulatory and stakeholder interests that must still be involved; although it might ensure more consistent advice to farmers. Farmers themselves have expressed doubts about the effectiveness of this (South Africa, United Kingdom) suggesting the emphasis should be simply on more efficient procedures.

In most countries private institutions or consultants usually undertake EIA on behalf of the aquaculturist. In several countries these must be government or agency approved. These consultants/institutions are usually EIA generalists – i.e. they are not aquaculture specialists, and this is flagged as a weakness in some of the ***Country Reviews***.

An ongoing problem in some countries is the poor relationship between farmers and one or more of the regulatory agencies. While this may be inevitable to some degree, there is no doubt that more positive relationships tend to generate more positive solutions. The example of Madagascar is instructive here – the shrimp farmers there have been especially pro-active in terms of improved environmental management (in order to avoid disease; and to access premium markets) and this inevitably makes for more positive relationships with the regulatory authorities.

A key factor in ensuring that relationships between institutions are clear, and that particular agendas or power relationships do not dominate procedures, is to have clear frameworks, protocols and guidance. Equally these must be sensitive and flexible enough to respond to local circumstances, needs and values. Guidance is intimately bound up with particular procedures and is discussed below in relation to these procedures.

CAPACITY

Capacity to implement EIA, other permitting and regulatory procedures and effective monitoring varies widely. The ***Africa Review*** suggests that many countries in that region lack the capacity and skills to implement sophisticated – and in some cases potentially draconian – legislation, much of it based on Western models. Furthermore, this legislation has been developed more in response to international pressure than to local perceived need. The author notes a lack of capacity at all levels: policy; regulation; administration; technical advice/consultants; industry associations; and public consultation procedures. Lack of capacity generally, especially at regional and local level, is also highlighted in the ***Latin America Review***. The ***Asia Review*** also notes the requirements for EIA and monitoring are ambitious relative to the capacity to deliver. Capacity is weak in several dimensions: general skills (although separate country papers do not identify this as a key constraint); access to necessary assessment and monitoring techniques; financial and institutional support; and enforcement.

In several countries there are schemes to register and certify EIA consultant organizations (e.g. India, Malaysia, Uganda, South Africa). In Malaysia government registered and qualified EIA consultants are published on the web. Uganda now has a database of registered and certified environmental assessment practitioners, and there is a professional association – the Ugandan Association of Impact Assessment.

There is a general tendency to decentralization of responsibility for managing aquaculture (in Asia, Africa, and some European countries). This is creating some capacity problems at local government level. This is mentioned in particular in the China and Indonesia ***Reviews*** and in the Latin American review. Recent experience of decentralization of responsibility for EIA in Scotland shows that even in developed countries, local government may find it difficult to access the skills required.

There is also a widespread lack of capacity in terms of the competence and skills of farmers themselves to respond to the complex procedures. Although larger farms can employ qualified staff or pay for appropriate consultant advice this is not feasible for the vast majority of farmers across the globe.

Another dimension of capacity is *feasibility*. Many procedures are impractical and inappropriate for small-scale cumulative development which dominates aquaculture production on a global scale. Conventional project EIA is neither feasible nor useful as a tool for the environmental management of such development, and attempts to apply it to a significant part of the aquaculture sector are doomed to fail, however much institutional capacity and professional skills are improved.

This becomes more obvious in relation to wider environmental issues – there is increasing emphasis on addressing ecology and ecosystem functions and this is often mentioned in EIA legislation. However, these issues cannot practically be addressed through individual farm EIA, which has necessarily tended to focus on "farm gate" issues of sediment and local water quality. The connections between this and the quality of the wider environment are rarely addressed: hence the call for ecosystem-wide approaches (Soto, Aguilar-Manjarrez and Hishamunda, 2008).

PLANNING AND MANAGEMENT FRAMEWORKS

Rights and permits

In most countries the prime mechanism for the environmental management of the aquaculture sector is the issue of licenses and/or a series of permits relating to both siting and operation. The issue of such rights is usually dependent upon some form of assessment, ranging from issue specific (e.g. effluent quality) to comprehensive EIA. On the basis of such assessment a single conditional license and/or a series of specific permits is issued. Every country is different in terms of the range of permits and associated assessments required. There are no obvious standard models.

The requirement for some form of licence is however almost universal, though in many countries may not apply to existing long established small-scale farms. In practice effective environmental management will either require some form of licensing for all established farms, or else rely on voluntary codes of conduct and market driven mechanisms. Rights and permits are usually issued for a specified period and this varies substantially between activities and countries, varying for example between 5 years for the right to farm shrimp in India (semi-intensive/intensive) to perpetuity in the case of license to farm fish in Scottish waters (recently increased from 15 years).

These official rights may be complicated by, overlap with, or in some cases conflict with local traditional rights. This has been a particular issue in some countries in Africa, where the EIA process for aquaculture has sometimes revealed conflicts between traditional land use and fishery rights and "modern" legal rights. Although aquaculture is very similar to agriculture, the creation of ponds is usually seen as bigger change than crops.

Zones, protected areas and standard rules

Many countries do not have formal planning relating specifically to aquaculture, but do have land and water use zones which may restrict aquaculture activity. Zones may be either positive (i.e. aquaculture development zones or parks) or negative (i.e. aquaculture is excluded or highly restricted). Positive zoning is relatively unusual, though well established in some countries such as China, Japan, Republic of Korea, and some Latin American countries.

"Negative zoning" is almost universal. In Egypt no aquaculture is allowed in freshwater, or where agriculture is productive. This has led to the main area for aquaculture development being brackish-water. In Thailand no new shrimp farming is allowed in mangrove areas or freshwater. In most countries there are protected areas or zones from which aquaculture is excluded, or where it is unlikely to be permitted. In Chile for example there are substantial areas where aquaculture is not allowed for environmental reasons. In Scotland (United Kingdom) the situation is less clear. Aquaculture is not permitted in certain areas related mainly to the sensitivity or capacity of the environment. In addition there are large areas where permits may be harder to secure – for example in National Scenic Areas which cover large swathes of areas also suitable for aquaculture. In India shrimp farming is not allowed within a certain distance of the sea or lake shore.

Local aquaculture plans

Some countries now require the development of more comprehensive local marine development and management plans which set the objectives, standards and conditions for any aquaculture development. The procedures may or may not include SEA or EIA. These usually include some form of zoning, and in the case of some Latin American countries include the identification of suitable areas for "aquaculture parks".

Marine or aquaculture plans should lead to more predictable, streamlined and consistent decision-making and permitting procedures. The main problem with this approach is the cost – typically substantial and usually falling to local government with limited resources. It is arguable however that framework plans of this kind amount to investment in "soft infrastructure" required to underpin sustainable development of the industry.

Some states in Australia with significant aquaculture activity (Tasmania; S. Australia) now have statutory marine aquaculture planning. Regional aquaculture plans are developed, subject to Area Environmental Assessment (a form of SEA), which define suitable areas or zones for aquaculture. These are then translated in practice as "lease zones", a licence for which will encapsulate appropriate management requirements, limits, monitoring/response etc in line with the objectives of the overall plan. Tenders are then invited for the leases within the zones.

Many aquaculture "Master Plans" have been developed in Viet Nam which include some provisions for zoning. In Malaysia informal assessments have been undertaken for zoning initiatives, such as the Sabah Master Plan for aquaculture development. In the United Kingdom one local authority has developed local "framework plans". In the Philippines the new National Code of Practice serves as the basis for local framework plans (see below). Planning for aquaculture is relatively highly developed in China and Japan as already described above.

Many countries have developed guidance related to planning and management of aquaculture. India for example has developed a comprehensive raft of aquaculture specific guidance, emanating from several different institutions: the Coastal Aquaculture Authority; the Ministry of Agriculture; the Marine Products Export Development Authority – including guidelines for sustainable aquaculture, and highlighting the importance of issues of protection of livelihoods of local people, etc. This guidance is mostly directed at coastal aquaculture, but beginning to be developed also for freshwater – in respect of *Macrobrachium* for example.

Aquaculture parks

Aquaculture "parks" have been promoted in some Latin American and Asian countries. In Brazil, such a park is defined as a *"continuous physical space on aquatic environment, which encompasses a set of aquaculture areas and where other activities compatible with aquaculture can also be realized."* Policy and regulation in Brazil also foresees the delimitation of preferential areas for small-scale aquaculture, defined as *"areas where allocation priority will be given to traditional communities attended by social inclusion programs".* In the case of Brazil these parks are very much part and parcel of the development of local plans for aquaculture development.

This represents a very positive approach to aquaculture development planning, but needs to be handled carefully. A concentration of activity of this sort, unless very well managed, may raise problems of waste disposal and biosecurity which may be less severe in more widely dispersed development.

Environmental capacity

A key issue for a more positive approach to aquaculture development – especially where zones or parks are being established - is the ability to predict carrying capacity for an area and so ensure sustainable production without breaching environmental quality standards – either for aquaculture itself or for other users. Many countries are seeking to develop and refine methods to make these assessments. This may be technically simple or challenging dependent on the nature of aquaculture and the receiving environment. The ***Reviews*** provide examples from Brazil, China, Japan, Philippines, and Scotland amongst others. The case study on Bolinao Bay (see Part 1) also illustrates possible approaches. Further examples and insights can be found in McKinnon, (2007) and Tett (2008).

CODES OF PRACTICE AND VOLUNTARY MEASURES

In most cases there is not an effective planning and management framework for aquaculture, and the costs of this in relation to very large numbers of small and existing farms may be prohibitive. In any case, it may be difficult to use such frameworks to influence routine farm practices. Industry codes of conduct (CoC) or best management practice (BMP) therefore represent an attractive way forward, and have the added advantage of potential tie-in with certification schemes and market premium. They have become widespread in recent years and have been promoted by both industry and government. The development of many such codes was in many cases initially driven by hygiene, food safety and export concerns, but is increasingly extended to encompass broader environmental and in some cases social concerns.

Codes of practice have been initiated by government, private sector and NGOs. Often they have been collaborative efforts. Their application in practice ranges from use as an image building tool for industry, as an independently certified marketing tool, or as a government requirement. The private sector has been proactive in many countries, seeing BMPs as both a marketing tool and as a means to reduce government regulation and bureaucracy (Tucker, Hargreaves and Boyd, 2008).

The Brazilian Shrimp Growers Association has developed four codes for best management practices (BMP) concerning shrimp farming, shrimp feed production, shrimp hatchery operation and shrimp processing plants. These are comprehensive addressing issues ranging from mangrove conservation and site selection to chemical use protocols and biosecurity. Madagascar offers a strong example of industry driven codes of practice. The major shrimp farming companies have been very proactive, recognising early on the need to strengthen their environmental credentials, minimize disease, and ensure that the industry developed steadily and sustainably. Most farms have achieved *Label Rouge* and/or *Organic* status. Some are now working with WWF toward eco-certification under the guidance of the International Principles for Responsible Shrimp Farming (FAO/NACA/UNEP/WB/WWF, 2006).

In China best practice initiatives have been widely promoted and developed in recent years by both government and private sector to the point where the number of initiatives and associated labels has perhaps become confusing. Examples include the *Wholesome Agriculture Production Action Plan*, the *Safety Agri-food Certification* scheme and the "*Green Food Standard*" (all administered by the Ministry of Agriculture). The last of these includes requirements relating to maximum dosages for fertilisers, chemicals, medicines, etc. There are now 230 certified fisheries products and producers. China also has a dedicated Good Aquaculture Practice (GAP) initiative administered by the Certification and Accreditation Administration. This includes a base module for aquaculture, supplemented by species specific modules.

In the Philippines a national and legally binding Code of Practice for aquaculture has been developed. This goes beyond many other codes in so far as it also defines permitting and regulatory procedures, as well as farm operation requirements and standards. As such it amounts to a complete management framework. The code includes for example a requirement for local government and producers to identify suitable zones and sites; a requirement for an environmental impact statement for new construction; and specific provisions for the spacing of cages and the need to establish carrying capacity. In addition to these planning related provisions, the code includes standard good practice provisions relating for example to organic waste, introductions, medicines etc.

Most countries now have some form of best management practice scheme (though subject to a wide variety of names), and although only occasionally explicitly defined as a legal requirement, adherence to best management practice is becoming the norm for any aquaculture product destined for export. Government in many countries has worked hard to facilitate introduction of these codes or related initiatives, including help to develop the codes and publishing associated guidance (see Mexico for example) or developing environmental strategies and associated action plans and inspection regimes at sector level (as in Cuba).

Increasingly these initiatives are also being extended to domestic product. India for example now has a National Centre for Sustainable Aquaculture which promotes best practice more broadly. One hundred societies of producers are now registered. Domestic market focused schemes are also increasingly common in China, as noted above. Over and above these national initiatives are international initiatives developed by agencies (such as FAO, the World Bank) and NGOs such as Naturland (organic certification) and WWF. The Marine Stewardship Council is also exploring certification of aquaculture.

STRATEGIC ENVIRONMENTAL ASSESSMENT (SEA)

Though widely recommended as a way to address the cumulative environmental effects of large numbers of small-scale aquaculture developments which characterize the bulk of aquaculture worldwide (e.g. GESAMP, 2001), the ***Regional*** and ***Salmon Reviews*** reveal that very few countries require or have implemented Strategic Environmental Assessment for aquaculture development. Strategic Environmental Assessment offers a comprehensive approach to identifying likely sectoral impacts, and establishing environmental objectives, standards, limits and so on for the industry – ideally as a of the basis for developing aquaculture development and management plans or integrated coastal zone management plans (ICZM). In practice any strategic planning process for aquaculture or natural resources more generally (e.g. integrated coastal zone management; river basin planning) which includes detailed consideration of sector level environmental impacts and management needs amounts to an SEA, and as such is already being implemented in several countries - for example in South Australia, New Zealand, Norway.

EIA

While all countries have some form of management and regulatory framework for aquaculture, complemented in some instances by voluntary measures, only a small proportion of aquaculture worldwide is, or has been, subject to EIA. To date EIA has only been applied consistently to some large scale shrimp farming projects in South East Asia, Africa and Latin America, and to marine finfish farming in Europe, Australia, North America and Latin America. This is unsurprising. As noted above, it is rarely feasible or useful to seek to apply it to large numbers of small-scale fish farm developments. Following, we offer only a brief overview on practices and experiences of the range of EIA procedures. The ***Regional Reviews*** offer a wealth of detail on specific practices which can be referred to as required. The key here is to report some of the key features of significance in terms of effectiveness.

Guidance

Most countries publish detailed guidance on EIA procedures. Three quarters of African countries have published EIA guidelines of which 50 percent refer to aquaculture. Some countries (e.g. Europe, Canada, South Africa) have developed detailed generic guidance for EIA and associated permitting procedures. In countries with significant marine fish farming detailed sector specific guidance is available (e.g. Canada, Chile, Norway, Scotland/United Kingdom). There is also regional and international guidance relating to aquaculture EIA. Many of these are referred to and listed in the ***Reviews***, and some of the key reference documents are listed in the bibliography to this section.

It is notable however, and of considerable concern, that the ***Reviews*** reveal a general lack of clear objectives for EIA and its role in environmental management of the sector. In particular it seems to be regarded in many cases as a kind of comprehensive stand alone process, whereas it can only be effective if its application and scope is tailored to and complementary with the overall sector environmental management system. More specifically, there are many issues which are better dealt with through targeted regulations, codes of practice or standard planning restrictions. EIA should be used to "catch" the more local and site specific issues which are not addressed through these more general mechanisms.

Procedures

The basic procedure for EIA is described above under section on requirements and is applied in most countries. The main variations relate to the terminology, the institutions involved, the detail of information required or collected at each stage, the extent of publication and public involvement, and the rigor or otherwise in terms of requirements for implementation, monitoring and evaluation. Some of these variations are discussed in more detail in the following sections.

Screening

Screening requirements have been described in previous section on legislation and requirements and it appears that practice broadly follows requirements, and most small-scale aquaculture is excluded at this stage.

There are two basic approaches: screening based on standard criteria such as farm production (e.g. United Kingdom) or screening based on professional judgement or the deliberation of a committee (e.g. India). The latter may be informed by some form of basic assessment or environmental statement on the part of the proposer. In some cases (e.g. Philippines, South Africa, United Republic of Tanzania) screening comprises both approaches – i.e. a first round screening out of proposals which come below standard thresholds; and screening of those above the thresholds through some form of pre-assessment. The result of this process is that only some proposals are required to undertake full EIA.

Scope, issues addressed and level of detail

The environmental impacts of aquaculture have been extensively reported and researched over the last three decades, and there is much guidance available as to what should be considered in aquaculture EIA. The following is broadly representative of the various "check-lists" available:

- Water column quality
- Sediments
- Waterbody/environmental capacity
- Disease, lice, mortalities
- Chemicals/medicines
- Alien species
- Escapes
- Genetic interactions
- Biodiversity (endangered species etc)
- Ecosystem
- Resource use conflict (navigation; fisheries; farming)

BOX 2
Guidance from Coastal Aquaculture Authority of India on important issues to address:

- Farm location, and whether a whole or part of the farm land falls within mangroves, wetlands and other land types
- Nearby land uses, including environmentally sensitive habitats
- Water source
- Potential impacts on water logging of adjacent areas or pollution of drinking water sources
- Existence of wastewater treatment facilities
- Use of supplementary feeds, drugs and medicines
- Activities which may cause siltation, turbidity, with detrimental implications for local fauna and flora

- Cultural (landscape; job quality)
- Social/economic issues
- Input sourcing

A more specific example is given in Box 2.

In most countries, EIA is very "farm gate" focused, with particular emphasis on potential for localized pollution and water quality impacts. Despite exhortation to consider and manage ecosystem scale effects (e.g. the Convention on Biological Diversity; the Abuja Declaration and the African Convention on the Conservation of Nature and Natural Resources) these wider issues are rarely addressed in EIA – and indeed it is difficult to see how they can be at the individual farm level.

Socio-economic impacts also tend to be given little attention – which given the name EIA is unsurprising. However this is a hugely important issue which is addressed in more detail in the following section. Resource and access issues in particular are often of great significance.

The level of detail required in an EIA is highly variable and in any case depends upon screening and scoping procedures described above. In many countries (e.g. Philippines, United Republic of Tanzania,) a preliminary EIA (referred to variously as initial environmental examination or statement) is required, and a full EIA is then only required if some of the identified impacts are deemed "likely to be significant".

ASSESSMENT AND DECISION-MAKING

Irrespective of the use of EIA, the nature of decision-making will ultimately determine the environmental performance of the sector. There are several key points at which critical decisions are made:

- decision by farmer to develop or propose development in a particular location;
- decision by authorities to undertake an assessment;
- decision by authorities on the scope of any assessment;
- decision by authorities to permit development and associated farm activities;
- decisions and choices on the part of farmer in terms of detailed nature of development and operation.

An important issue at each of these stages is the extent of public consultation or participation.

Siting decisions

Siting is a crucial factor which determines the environmental impact of aquaculture, yet the ***Reviews*** were unable to offer much evidence about how site selection decisions are made.

In most cases siting decisions are made by the farmer based on availability, cost, and suitability. To some degree a consideration of suitability will encompass environmental considerations, since a good site must have appropriate (usually high) water quality and capacity to assimilate or disperse waste. However in most cases a small farmer will lack the expertise or opportunity to address these issues. In many cases there will be no "site selection": the farmer will simply respond to an opportunity in terms of land/water/rights availability. In some cases the authorities themselves facilitate a process to identify suitable zones for particular forms of aquaculture, which then serve to guide or constrain siting (e.g. Australia (Tasmania), Brazil, China, New Zealand, South Africa, Spain) in line with environmental and other interests.

Although alternative sites should be considered in best practice EIA, there is no evidence from the ***Reviews*** that this occurs, and indeed it appears to be rare. This is unsurprising: the additional costs of EIA relating to two or more sites would be substantial. In Scotland (United Kingdom) and Norway however, farmers are encouraged to engage in "pre-consultations" with regard to different possible sites, before making a full proposal.

Screening and scoping decisions

Screening decisions are usually based on standard criteria as discussed in previous section on legislation and requirements. In some cases however they may fall to a technical official or local government employee. Scoping decisions are usually made by technical agencies and government officials, although in some cases key stakeholders may also be involved in the form of an "ad hoc" committee.

Assessment and permitting decision procedures

These are the key decisions which ultimately determine the overall pattern of development of the aquaculture industry, irrespective of the use of formal EIA.

Assessment is often difficult and inconsistent. The key to consistency is the availability of national and/or local standards or baselines against which to make the assessment – and these are dealt with below. The ***Africa Review*** in particular notes a lack of baselines and standards against which to assess. Where these are available they are often derived from other countries and may be inappropriate to specific African contexts. This problem is common to many less developed countries across the globe.

However, standards are only part of the process. There will always be an element of subjectivity – and the need to make decisions appropriate to the local situation. The inclusiveness and transparency of the decision-making process, and the nature of the "final arbiter" is therefore a key issue. In practice there is enormous variation in this worldwide, reflecting political systems and governmental structures, the scale and nature of fish farming, public attitudes and perceptions and so on. Just a few examples are offered here to illustrate the variation.

In many countries (e.g. Malaysia) review of EIA reports is undertaken by the Department of Environment, with assistance from an ad hoc review panel, which may include both technical specialists and stakeholder representatives. In India (for shrimp farming) the ultimate permitting decision lies with the Coastal Aquaculture Authority. They are supported/advised by a district committee led by the head of local administration and assistant director of fisheries. This includes representatives of a variety of boards and departments (e.g. pollution control, planning, etc). At state level a similar committee is led by the secretary (fisheries) also with wide representation. The approval process may require site visits by committee members. In Indonesia, for larger farms, an EIA report plus environmental management plan, plus an environmental monitoring plan is submitted to a national, regional or municipal Commission of Appraisal. Consent itself is awarded by provincial governor or by head of local district. In the United Kingdom a local government planning committee will make the final decision on planning permission, but this will also be contingent on more technical approvals and permits from the environment agency. In Japan new farms are screened by ad hoc committee – comprising local government, fishery cooperative associations, academics and others.

The extent of public participation in this process is usually limited except for very large developments. However, many countries have laws requiring publication of and access to proposals and associated documents, including EIA. In some countries there is a specific requirement for press and occasionally radio announcements. Access may however be restricted in parts by rights to confidentiality (e.g. Brazil, Mexico). In many European countries the planning process may specifically encourage letters of support or objection which will be taken into account in the final decision. This can create a good deal of uncertainty since most submissions will inevitably be negative. In several countries (e.g. Brazil, Norway) a public hearing may be required before final approval. In Colombia a public hearing may be requested on any EIA evaluated project, and such a hearing is specifically required before an environmental license can be issued in regions where black and indigenous populations exist.

Design and operational decisions

These are influenced by the EIA review outcomes, by the skills and knowledge of the proposer, by industry guidance and training, and by codes of practice and standards. In practice these can be strongly influenced by extension services where these are effective, and this is an area which probably has the greatest potential for influencing the environmental performance of large numbers of smaller farmers.

Overview of decision-making structures and procedures

Table 1 offers some examples of the various decision-making powers and institutions relating to different stages of the EIA process. In practice every country is different - there are no standard models – and it is difficult to draw out general conclusions about the effectiveness of alternative approaches, although these are discussed further below.

Decision tools and decision support

EIA and alternative or complementary environmental management procedures tend to generate large amounts of information on impacts, possible or potential impacts, and possible solutions. It is typically difficult for individuals or review panels to make

TABLE 1
Examples of decision-making powers and procedures

Siting	Screening/scoping	Assessment/permitting	Design/operation
Farmer decision (often few available options). In most countries there are specified no-go areas, excluding aquaculture In some countries (e.g. Australia) a strategic plan may include zonation which will limit or guide farmer siting decisions.	• Usually a technical government official in environment or fisheries agency. • May be advised by a technical or representative committee.	• Department of Environment (e.g. Malaysia) with assistance of review panel (technical specialists and sometimes stakeholder representatives). • Department of Fisheries (e.g. Viet Nam) or specialist Agency (e.g. Coastal Aquaculture Authority in India) – again advised by a technical and/or representative committee. • Commission of Appraisal/ representative committee (e.g. Indonesia, Japan) • Local Government (e.g. United Kingdom) advised by government agencies and planners	The farmer, but influenced by: • Skills, knowledge, extension; • Standard regulations; • EIA environmental management plan; • Code of practice; • Local plans.

objective decisions on the basis of all this information. A variety of factors can help inform and support decisions:

- national or local environmental objectives and standards;
- environmental capacity analysis and modelling;
- risk analysis;
- public consultation.

STANDARDS

The existence and use of standards as part of the environmental management of aquaculture, and to inform permitting procedures, enforcement, EIA and other procedures is highly variable. In many countries water quality standards are well developed, and in Europe these are now being applied in relation to particular waterbodies. In developing countries water quality standards have sometimes been copied from developed countries and may not reflect local conditions or needs. However ASEAN water quality standards for example are now being developed.

In many countries standards are applied in relation to the effluent quality itself. In India and Viet Nam for example there are now national standards for wastewater from aquaculture. These are of two types – for discharge to coastal marine waters, and for discharge to creeks/estuaries. While these serve as a starting point for limiting discharges, they do not take account of the capacity or characteristics of a particular waterbody. However some standards may be developed under the Indian State level Pollution Control Board which do take account of local circumstances. In some countries (including the whole of the European Union) water quality objectives and standards are being developed for individual waterbodies, according to their ecological nature, the types of use to which they are put, and local needs more generally. The following are just a few examples to illustrate the range and nature of such standards and how they relate to the management of aquaculture.

Marine waters in China have been divided up into 651 coastal environmental function areas, each of which has been assigned a classification:

Class I: Fishery waters; marine nature reserves
Class II: Mariculture areas
Class III: General industrial and coastal scenic spots
Class IV: Port and marine development areas.

For each class there is a set of appropriate water quality standards. Similarly there are five classes of freshwaterbodies. Class V – for agricultural use – also includes aquaculture. In Indonesia there are national standards, supplemented by local water quality standards (which may be related to use zones), with the standard applied appropriate for the most sensitive use. In Europe River Basin Plans are drawn up (under the Water Framework Directive) for major watersheds or groups of watersheds, with objectives and standards drawn up for smaller component waterbodies. These go beyond many previous standards in so far as some relate to "good ecological status" rather than solely to water quality. In all cases these standards serve as a key yardstick for EIA and other aquaculture permitting procedures.

CARRYING CAPACITY AND ENVIRONMENTAL CAPACITY

A key issue for environmental assessment and permitting procedures, including in particular permits to discharge nutrients or other wastes to a waterbody, is the extent to which the discharges may lead to a deterioration of water quality or ecological characteristics below the standards established for that waterbody. To address this requires an understanding and assessment of assimilative (environmental) capacity. In practice this can be difficult, which is why in most cases environmental management depends upon a combination of relatively arbitrary limits to waste discharge (in terms of quantity or concentration in wastewater) coupled with monitoring of the wider waterbody to ensure standards are not compromised. The problem with this approach is that it is very difficult to reduce existing aquaculture or other activities once such standards are breached. If environmental capacity can be estimated, then strategic precautionary limits might be placed on aquaculture and other activities to ensure that standards are not breached.

Experts in many countries are now working hard to develop environmental capacity models for a range of waterbodies, including Brazil, China, Indonesia, Japan, Norway, the Philippines, Scotland, and Viet Nam. In Japan these assessments are used to inform "Aquaculture Ground Improvement Plans". In Scotland they inform "locational guidelines" and are being developed further for particular waterbodies. In Brazil they are being used to inform the development of aquaculture "parks".

There are interesting and substantial differences in the interpretation of the meaning of environmental capacity, reflecting the history of, and public attitudes to aquaculture. Experts in Japan, with its long established intensive marine farming industry, have studied environmental capacity issues for some time. Here the approach has been to define environmental capacity in terms of the *maximum rate of assimilation*. Benthic oxygen uptake is taken as an indicator of the rate of mineralization and benthic ecosystem activity. This peaks at a certain organic matter loading, beyond which function is clearly impaired. This is taken to correspond to environmental capacity – and the total organic matter loading from farms must not be allowed to exceed this amount. This is an example of managing the environment to maximize an environmental service (i.e. organic matter mineralization) – in this case a service to the aquaculture industry itself. This contrasts with the approach in many other countries, where environmental capacity is usually defined in terms of the organic matter or nutrient loading which can be accommodated without breaching the particular water quality standard agreed for that waterbody – usually through reference to historic water quality, national standards, or as agreed with other users. In other words the focus is not just on ensuring sustainable aquaculture, but on maintaining water quality for a variety of reasons. Japan has also developed indices of site suitability based on "embayment degree" and specific characteristics (water/sediment/fauna) which to some degree serve as indicators of environmental capacity. This is a similar approach to that used in Scotland (United Kingdom) to inform locational guidelines for fish farming through estimates of flushing rates.

COMPLEXITY, UNCERTAINTY AND IGNORANCE

While it may be difficult to estimate environmental capacity, or agree on acceptable levels of change to sediment and water quality, it may be even more difficult to make objective assessments of the significance and acceptability of other impacts. The effect of introductions is particularly difficult to assess, and complex trade-offs between ecological risks and economic benefits may be involved. The introduction of Nile perch into some countries in Africa illustrates some of the difficulties. There have been spectacular changes, and scientists still do not know how resulting effects and situations will continue to evolve. This in turn has resulted in a complex set of costs and benefits, and changes in the social distribution of these.

There are some innovative approaches to addressing the problems associated with uncertainty, risk and ignorance. In South Africa the following provision applies to any introduction of species:

> *"Should an alien species establish itself in nature as an invasive species because of the actions of a specific person, a competent authority may hold that person liable for any costs incurred in the control and eradication of that species".*

In other words, the dilemma of deciding on acceptable levels of precaution is shifted from government to developer, by making him/her responsible for the costs of any possible impacts.

RISK ANALYSIS

Increasingly risk analysis is being seen as a key tool to assist in screening, scoping and decision-making (GESAMP, 2008). In South Australia (fresh waters) for example there is now strong emphasis on a risk based approach to assessment. A risk profile of proposals is developed dependent upon the manner in which water is discharged (none, controlled, uncontrolled) and the amount of feed input (natural; minor manufactured; major manufactured). This risk profile is used to determine the scope of the assessment and need for mitigation, monitoring, etc. Risk based approaches are also being promoted in New Zealand. It should also be recognized that the risk analysis approach often has been used implicitly in screening and scoping procedures for many years.

Like any form of assessment however, standard risk analysis must be informed by thorough technical knowledge. Thus a fully recycled system should only be classed as of lower risk if there are effective procedures for disposing of waste that accumulates within the system. Equally while shellfish farming may be classed as low risk because it uses natural food, a high concentration of shellfish generate a very large quantity of faeces and pseudo-feces, and remove a great deal of natural food from the water column with a variety of ecological consequences.

PUBLIC CONSULTATION AND INFORMATION

In practice the quality of the environment is a matter of public (or political) choice, though informed by science as far as possible. Any effective planning and management regime and/or environmental assessment process should therefore include public consultation. Though specifically required in most environmental legislation, and in particular as part of SEA and EIA, the extent and nature of public consultation is highly variable throughout the world.

Generally, there are four main dimensions to public consultation:

1. Sourcing of information to inform siting and management issues;
2. Provision of information to ensure that stakeholders are well informed of potential plans or developments;
3. Understanding of other user and stakeholder interests and perspectives;
4. Participation in decision-making.

In most countries the third of these appears to have been the focus of most consultations. The problem with the fourth is that it introduces a considerable element of uncertainty into the decision-making process.

The regional ***Reviews*** offer some interesting and innovative examples of public consultation. The United Republic of Tanzania for example has strong regulatory guidance on public participation – in terms of the need to seek views, publicise, and hold facilitated meetings. In Zanzibar a mechanism is provided for out of court settlements of environmental disputes. Special "environmental mediators", acceptable to all parties, and trained in dispute resolution can be appointed. Some larger companies may approach public consultation from a more self interested economic perspective – offering to employ local staff, training, supporting outgrower schemes, and providing community funds.

Many of the ***Reviews*** highlight significant weaknesses in information provision and transparency. In most countries it is difficult to access EIA documents or ascertain the basis of assessment decisions. However, things may be changing. China for example has just (May 2008) introduced new measures requiring disclosure of environmental information. The responsible authority in Mexico publishes a weekly list of aquaculture licenses granted, and any citizen has the right of access to information relating to EIA and environmental licensing. In Australia and New Zealand public consultation is a key component in identifying and defining aquaculture zones. This is seen as much less confrontational than that typically associated with project EIA, where the developer already has "sunk investment" in site identification and proposal development/ feasibility studies, and by which time it is difficult to consider alternatives. Identifying zones on the other hand should allow for *give and take* and negotiated solutions taking account of all interests.

As noted above public *representation* may be a feature of assessment committees and review boards. Thus in Indonesia the "Commission of Appraisal" may include representatives of user groups, technical specialists, NGOs, etc. In Mexico "Regional Sustainable Development Councils" representative of a broad cross sector of society, have been established and may be consulted by officials involved in aquaculture permitting procedures. In Brazil and Colombia there is a "National Council for the Environment", again representative of a wide range of interests and stakeholders but at national level. The involvement of these higher level representative bodies allows for a more strategic representation of the many interests and the development/negotiation of compromise, and may be used to overcome to some extent, the confrontation that frequently occurs where public involvement is solicited on a case by case basis. Some caution is required in the interpretation of differences in apparent levels of public consultation. In Cuba for example the legal emphasis is on consultation with the various relevant state institutions rather than the wider public, but Cuba has relatively strong community representation within these institutions.

One of the most difficult issues associated with public consultation is the introduction of significant levels of uncertainty about the outcome of any assessment. Thus a developer can take all feasible measures to estimate and mitigate impacts, and ensure the enterprise stays within acceptable national or regional standards, yet opposition to development from particular sectors of society may result in refusal to permit the development. This may even threaten the viability of a business. The example of a local fishing company proposal for development of shrimp farming in the Rufiji Delta may be seen as a case in point (***Africa Review***). Though comprehensive project planning and environmental assessment was undertaken at great cost, local opposition was such that it was eventually turned down, and the company went into liquidation. On a smaller scale and usually with less dramatic consequences, similar problems are encountered by aquaculturists in Scotland. Such uncertainty may be reduced by very early engagement with local interests which is encouraged in many countries, but the dynamics of public opposition are often complex and unpredictable.

Overall however, the ***Reviews*** suggest that public consultation is often weak, and information not readily available. Again, these issues may be avoided to a large degree through more strategic planning as noted above.

MONITORING AND REPORTING

Given the uncertainties associated with environmental impacts, monitoring is essential, whether in relation to EIA and specific enterprises or to the regulation and management of the sector as a whole.

Environmental monitoring is a significant activity in most countries, typically undertaken by government authorities. Where fish farming is larger scale, companies usually undertake their own monitoring – either as required by government (sometimes directly arising from EIA and associated EMP), or for their own management information. Most countries also have national water quality monitoring systems which are not specifically related to aquaculture but serve to alert public authorities of any problems which may arise.

In some countries third parties may be involved – or partnerships of interest (e.g. Philippines) to ensure neutrality and representation of stakeholder interests. In Japan, fishery cooperative associations are required to undertake monitoring and reporting for the farms in their area, assisted in some cases by prefectural fishery stations. In the Philippines there is provision for *Programmatic Environmental Performance Report and Management Plan* – but this has not yet been implemented in coastal and lake based aquaculture. In Ecuador a random periodic environmental audit is required for farms that have been subject to EIA, undertaken by qualified consultants registered and authorized by the national authority. In New Zealand and Australia monitoring programmes may relate directly to marine plans or aquaculture development plans, and be tailored to particular issues and zones as required. In China there is now a major sector related monitoring programme – the Fishery Environmental Monitoring network – covering 21 million hectares, with a major centre in Beijing. This covers inland and nearshore coastal waters with both disease and environmental components. A similar system is being developed in Viet Nam.

Monitoring typically relates to sediment quality and water quality, with different countries using different suites of indicators (sometimes complex), although there is much commonality. Most countries also monitor shellfish waters for pathogens and toxic algae to ensure safe shellfish products. Sediment quality is usually monitored using redox or sulphide measurements. Water quality may be determined by reference to suspended solids, dissolved oxygen, ammonia, nitrogen and phosphorus concentrations. Monitoring of benthic fauna is relatively frequent in many countries. In some countries requirements now include video survey, supplemented by periodic sediment checks. Video transect survey has the advantage of relatively low cost and the capacity to address both sediment and biodiversity issues.

Monitoring can represent a significant cost – up to US$20 000 per year for larger farms in developed countries (see for example ***Salmon Review; ENA Review***; Poseidon, 2008). A few countries (for example Honduras) may require a *bond*, or "economic collateral deposit", in the case of high environmental risk projects before a license can be issued. This serves on the one hand to discourage high environmental risk taking, and on the other to provide for remediation and restoration should environmental damage occur.

As discussed below, although monitoring is widespread, feedback into management systems appears to be weak in many countries.

OVERVIEW OF DISTINCTIVE OR INNOVATIVE FEATURES

Most countries have complex procedures relating to the environmental management of aquaculture, which are well described in the ***Reviews***. It is impossible to summarize and compare all the different elements and features of the environmental management and EIA procedures in the countries covered, and it is difficult to pick out and analyse specific subsidiary procedures, since these are often mutually dependent and cannot be fully understood in isolation.

Nonetheless there are important differences between countries, and some interesting or innovative features which may have relevance for other countries, particularly in terms of setting a more effective context and framework for EIA and monitoring. The features highlighted below have been selected as of interest in terms of exemplifying a particular approach or technique. Where this is of specific interest to the reader, he/she should refer to the more detailed descriptions and context presented in the ***Reviews***.

This summary overview is necessarily selective and subjective, and should in no way be seen as a summary of key procedures.

TABLE 2

Overview of selected notable or innovative features

a) Africa

Country	Selected notable or innovative features
Egypt	• Very long tradition of regulation and management of scarce water resources, closely allied with irrigation management rather than EIA legislation. • Particularly strong with respect to the allocation of *rights to competing users*, and social impact issues more generally.
Madagascar	• Legal framework explicitly recognizes the need for a *balance* between investment and environmental quality. • Specific law on responsible and sustainable aquaculture development. • *Shrimp industry has been very pro-active* in establishing environmental standards, and has been successful in maintaining low levels of disease, high quality product and associated price premium.
Nigeria	Quality of the environment enshrined in the federal *constitution*.
South Africa	• Right to a healthy environment and sustainable development are both *enshrined in the constitution*. • *Hierarchy of requirements* for SEA, EIA, ERA, EMPs. • Problem of alien species is addressed through provision for *liability* in the Biodiversity Act: • *"Should an alien species establish itself in nature as an invasive species because of the actions of a specific person, a competent authority may hold that person liable for any costs incurred in the control and eradication of that species"*.
Uganda	• Area environmental officers and *environmental liaison units* have been established *within* sectoral departments/agencies to promote *integration*. • *Standards* for sourcing and certification of aquaculture inputs, import of live fish and GMO.
United Republic of Tanzania	• High level of *environmental awareness*. • Introduction of Nile perch offers an excellent case study on the issue of *alien species.* • An innovative mechanism is provided for *out of court settlements of environmental disputes*, through specially trained environmental mediators. • Strong regulatory guidance on *public participation*.

b) Asia-Pacific

Country	Innovative or notable features
Australia	• Tasmania and South Australia have *statutory marine aquaculture planning*. Regional aquaculture plans are developed subject to area environmental assessment + zoning, including suitable areas for aquaculture. This translates in practice as lease zones for which tenders are invited, and conditional licenses which specify management and monitoring requirements. • In fresh waters in South Australia, the emphasis is on *risk based approach* to assessment, with the objective of sustaining "beneficial uses" of rivers/watersheds.
China	• Many aquaculture product *certification* initiatives. The overview body: China certification and accreditation administration has developed specific aquaculture modules. • Strong national environmental protection agency with subsidiary bureaux within - and partly dependent on - each level of government, thus facilitating *integration*. • EIA reports must be produced by *government certified agencies* (e.g. Universities, research stations). • *Fishery environmental monitoring network* – covering 21 million ha – addresses both disease and environmental parameters. • Waterbody *zoning* with specific environmental quality standards (EQS) for mariculture areas is being developed. • New legal measures for *public disclosure* of environmental information.
India	• A *sector level environmental assessment* undertaken of shrimp farming for the Supreme Court in 1996 raised awareness and served as basis for much legislation, regulation and guidance. • Aquaculture operating license *valid* for only 5 years.
Indonesia	• EIA etc submitted to a *"Commission of Appraisal"*. • *Environmental capacity* models used for freshwaterbodies, and being developed for marine areas.
Japan	• 1999 Law to ensure sustainable aquaculture production. Focus is on monitoring, management and evaluation of capacity. Very little application of EIA to aquaculture. Emphasis is on *protection of aquaculture from other pollution threats*. • *Environmental management delegated* to area based fishery cooperative associations (FCAs) with some regulation/support from prefecture. FCAs are required to develop and implement adaptive "aquaculture ground improvement plans". • *Environmental capacity estimates* are normally based on sustaining ecosystem service to farmers (e.g. organic matter assimilation) rather than conserving a pristine environment. • Acid volatile sulphide (AVS) is considered to be the most *cost effective indicator.*
Malaysia	• List of independent but government *approved environmental assessment consultants published on the web.* • *Public participation* is required under federal EIA procedures. • Malaysia aquafarm *certification scheme* – voluntary, but managed by department of fisheries.

b) Asia-Pacific (continued)

Philippines	• *Constitutional guidance* on natural resource management. The Law requires "a rational balance between socio-economic development and environmental protection". • *National code of practice for aquaculture* encompasses best practice in planning and assessment by local government as well as operational recommendations. • Provision for *programme level EIS* including environmental capacity, risk analysis, and provision for environmental guarantee funds. • Detailed provisions for *monitoring* delivered through a range of mechanisms including national agencies, farmers, third parties. May include *multi-partite monitoring team* to encourage stakeholder participation. • Farms wishing to expand must submit *historic data* on environmental performance and impact. • *Environmental capacity* being explored under Philippines/EU Philminaq project.
Thailand	• *National aquaculture production and management plan*: 5 percent target growth rate - in balance with sustainability objectives. Local strategic aquaculture and natural resource plans in line with national plan. • *Farm registration* (covers 95% of farms) dependent on environmental evaluation by provincial fishery office in collaboration with local administration. • National government promoted and audited *good aquaculture practice (GAP) programme including code of conduct (CoC)* for shrimp farming – now shifting to independent management and audit. Bank loan to a farmer in Thailand is conditional on GAP/CoC adherence. • *Ban* on shrimp farming in freshwater areas and designated mangrove areas. • *Large companies have played a major role* in helping develop environmental management systems. • Rejection of contaminated product has had a significant effect on the use of chemicals.
Viet Nam	• *Sectoral plans and strategies well developed* and increasingly subject to SEA (under 2005 law). • A "*Commitment of environmental protection*" is required for small household business before granting land-use license. Appraised by district peoples committees. • Many *standards/codes* currently in preparation. • National *environmental/disease monitoring and early warning programme* for aquaculture.

c) Europe

Country	Innovative or notable features
France	• Inland aquaculture not permitted where *threat to native fish* populations. • *Strong public consultation* element with an "investigating commissioner" a) billposting; b) holding public consultation, c) interviewing the applicant and d) providing the "investigative commissioners report" to prefect. • Comprehensive *monitoring networks for shellfish* waters – water quality, microbiology, toxic plankton.
Hungary	• Carp pond *aquaculture synergistic with nature conservation* and biological water treatment. Many farms enrolled in "agricultural environmental protection programmes" and some are important nature reserves and recreational facilities.
Italy	• *National fisheries and aquaculture policy* with three year rolling plans revised annually. • Use a *trophic index to classify waters*
Norway	• Well developed *coastal management* procedures. • Total production controlled through periodic *public issue of production rights* through licenses. • "Nytek" *national standards* have been developed for *equipment* and siting. • Site based *modelling-on-growing-monitoring system (MoM*). The rigour of monitoring requirements depends on degree of exploitation and impact.
Poland	• Carp ponds deemed to have *insignificant impact* on the environment. • New *national strategy* for the development of fisheries.
Spain	• Inland aquaculture very *low priority* in terms of allocation of scarce water resources.
Turkey	• Since 2006 *marine cages are excluded* from environmentally sensitive areas, enclosed bays and near shore areas. Many appeals are now in process. • *A eutrophication index* is used as a key decision criterion/monitoring tool. • Site/production licenses are *reviewed every two years*. • *ICZM* is being implemented including site allocation plans
United Kingdom	• An *allowable zone of effect* is prescribed, beyond which there should be no discernible impact. • EIA must focus "on only those impacts liable to have a significant effect on the environment" • Heavy emphasis on pre-consultation to inform site choice and make planning and consenting process more predictable. • Significant *monitoring* undertaken by operators according to a prescribed formula. • In freshwaterbodies farms are not normally allowed to *change trophic status*.

d) Americas

Country	Innovative or notable features
Brazil	• Ministry of fisheries and agriculture is investing in *local plans* for marine aquaculture development. • three *environmental licenses* required: preliminary, installation, and operational. • Representative *national environmental councils* may play a role in decision-making relating to environmental licenses. • Aquaculture parks have been established to promote development and rationalise assessment and establishment procedures.
Ecuador	Five farms comply with "Naturland" *organic* label.
Mexico	• *Aquaculture management plans* are developed for regions with similar environmental and aquaculture technology characteristics. • An aquaculture "*chart*" is published annually, detailing status, impacts, technology and management. • Recently enacted laws of *transparency* and access to information allow any citizen to get access to and consult all information regarding EIA and environmental licensing. • In difficult cases, *regional sustainable development councils* (including stakeholders and representatives) may play a role in decision-making relating to environmental licences.
United States of America	• Formal *EIA* is not a federal requirement, though some states currently (or will shortly) require it. • A rigorous permitting procedure is supported by *standards* (for effluents and receiving waters) coupled with *codes* of conduct and wider *monitoring*, delivering comprehensive environmental management.

Effectiveness

LEGAL FRAMEWORKS

The regional ***Reviews and Salmon Review*** offer limited insight into the strengths and weaknesses of alternative legal frameworks. This is perhaps unsurprising: the legal framework is intimately related to the history and development of each country, and that of the aquaculture sector, and the "ideal framework" can only be considered on a country by country basis. Nonetheless it appears that in many cases the legal framework is over-ambitious. There has been a tendency for developing countries to use developed country legislation as a model, taking little account of the more limited technical and administrative capacity to implement, and the diversity of aquaculture development.

EXTENT OF APPLICATION OF EIA TO AQUACULTURE

In global terms EIA procedures have only been applied to a very small proportion of aquaculture – mainly to large scale marine finfish farming in Europe, North and South America, Australia and New Zealand, and to major industrial scale shrimp farming projects in Africa and Latin America. The bulk of fish farming in Asia – which dominates global aquaculture production – is in effect untouched by EIA procedures. This is unsurprising. It is estimated that there are fourteen million aquaculture farmers in Asia (Corsin, Funge-Smith and Clausen, 2007), many of whom have been established for a long time and in some cases centuries. EIA cannot be used as an effective tool for the environmental management of aquaculture in these circumstances. Alternative approaches, such as environmental monitoring and regulatory response, extension, voluntary "good aquaculture practice (GAP)" and market led initiatives are required, and are already widespread.

EFFECTIVENESS OF EIA

The ***Reviews*** offer very little evidence of the effectiveness, and particularly cost effectiveness of EIA for aquaculture. In most cases there is little evidence that EIA procedures have led to improved environmental management; and at the same time frustration on the part of producers and developers at the delay and bureaucracy with which it is often associated. Several weaknesses are identified in most countries (see Box 3). In general these weaknesses are more significant with respect to small-scale producers.

Lack of standards and consistency

Consistent and transparent assessment can only take place if there is consistent guidance, baselines, and standards against which to measure the significance of impacts and which might serve as the basis of targets for mitigation. Many countries do have standards, and these are being further developed in most countries to meet modern expectations. However, these remain inadequate in many countries, especially in terms of reflecting local needs and conditions. Local marine, river basin or aquaculture sector plans are an important way to establish such standards and the ***Reviews*** reveal several useful examples of this approach.

However, the existence of standards for the aquatic systems within which aquaculture operates does not translate easily into standards for effluents from fish farms, without an understanding of *environmental capacity*. Although models are being developed in

BOX 3

Some of the weaknesses of EIA identified in the Regional Reviews

- Cannot address large numbers of small farms and cumulative impacts.
- Inadequate baseline data.
- Lack of objective and/or locally appropriate objectives and standards by which to assess.
- Complex, subjective and speculative, especially with respect to effects on landscape, local community and society.
- Lack of technical and decision-making capacity.
- Lack of capacity to undertake monitoring.
- Lack of effective monitoring, and feedback into management of individual farms and the sector more generally.
- Lack of enforcement of EMPs.
- Lack of sharing of EIA generated information.
- Ineffective public consultation procedures.
- Complex, delaying and bureaucratic; often perceived as bureaucratic process rather than management tool.
- Lack of clarity of institutional responsibilities.
- Difficulty of dealing with land ownership/use/rights issues.

many parts of the world, these are often difficult to apply in practice, especially in areas dominated by pond aquaculture (Hambrey *et al.*, 2004). In many situations therefore monitoring will be an essential part of assessment, and EIA without monitoring rather limited in utility. Several countries have national standards for aquaculture effluents, but these are of limited value without an understanding of local assimilation.

Lack of assessing and decision-making capacity

The utility of EIA depends critically on the way it is used in the permitting procedure, and the skills and judgment of those making decisions. Several of the ***Reviews*** noted a lack of technical capacity to make informed assessments and decisions, especially at local level.

Complexity and subjectivity of ecological impacts

While water quality issues may be addressed through a combination of national standards, modeling and monitoring, ecological impacts – other than direct conversion of habitat – are usually difficult to predict, and the significance of any change difficult to assess. While this is becoming an important area for EIA in developed countries the issues addressed are often subjective. Acceptable ecological change is not easy to define, although ICZM and river basin planning initiatives are beginning to address these issues. Western countries increasingly define acceptable ecological change beyond the immediate boundaries of the aquaculture enterprise as being zero. This is implicit in the "acceptable zone of effect" used in the management of finfish farming in Scotland (United Kingdom), and "good ecological status" used as a benchmark under the Water Framework Directive in Europe. In developing countries on the other hand significant change is likely to be acceptable except in designated protected areas, or with respect to particular habitats such as e.g. coral reef and mangrove.

Lack of suitability to address siting issues

A significant weakness of EIA as applied to aquaculture is its weakness in addressing siting issues – a major dimension of environmental management. In most cases a farmer chooses a site because of its availability, accessibility and cost. In some cases – and especially for vast numbers of small-scale farmers in Asia, it is simply a question of digging ponds on existing farms. Best practice EIA should consider alternative sites – but typically, by the time the EIA is undertaken a site has been chosen and the EIA refers primarily to this site. In any case the cost of undertaking EIA in relation to several sites may be prohibitive except for very large developments.

Lack of suitability to address cumulative impacts and effects on the wider environment

All the regional ***Reviews***, and many previous studies, have noted the inadequacy of EIA to address the cumulative impacts of large numbers of small-scale development, typical of much aquaculture production worldwide. Some form of strategic environmental assessment, or environmental assessment applied to clusters of farms (see ***Bolinao Bay Case***), coupled with analysis of environmental capacity issues, preferably as part of a comprehensive natural resource planning and management system, is the only way to tackle these issues (GESAMP, 2001). Cumulative impacts are also associated with disease, and again this requires a sector wide approach to management.

Lack of suitability to address introduction of alien species or GMO

It is similarly difficult – or unnecessary – to tackle issues of introduction of alien species through EIA, and the ***Regional Reviews*** suggest that EIA has indeed been largely ineffective in this regard. There are local, national and regional risks associated with introductions, as a well as a highly uncertain set of costs, benefits and distributional issues. It is clear that this should be a question of national policy, possibly with regional variations, but the issues typically go well beyond what an individual farm EIA can deliver – except again in relation to very large scale developments involving detailed analysis and national level appraisal.

Sometimes negative and confrontational nature

Although EIA is often promoted as a possible mechanism to pre-empt conflict, it can equally serve as a stimulus to conflict. Public participation, though widely regarded as a key element in best practice EIA, must be undertaken with great care. For example it can highlight conflicts between traditional and modern access rights, as exemplified in the Rufiji Delta example from Africa. It can serve as a focus for debate between conservation orientated interests and development interest – and one in which compromise is extremely difficult.

If on the other hand social and economic issues are not addressed, and the emphasis is on developing practical mitigation measures and an environmental management plan, then although there may be little conflict, the rationale for EIA comes into question: there may be simpler standardized approaches to achieving these outcomes, through the implementation of standard regulations, or codes of conduct.

Inadequate public consultation

Several of the ***Reviews*** highlight weak or insufficient public consultation. However, as noted above, individual EIA may not be the best focus for debate over fish farm development and management, and may lead to rapid polarization of opinion. Public consultation as part of more strategic approaches to planning and management of fish farm development is likely to be much more effective and constructive.

Scope and lack of focus

Some of the ***Reviews*** note the breadth and lack of depth of many EIAs. There is a tendency to tabulate and discuss all possible activities and associated impacts, only a few of which are significant. This problem is well known and should be addressed through correct scoping procedures including risk analysis, before resources are concentrated on exploring and defining mitigation measures for a few critical impacts. This may be done as a separate scoping exercise by the authorities, or as part of the EIA process itself.

It is also important to recognize that many environmental issues can be effectively addressed through other mechanisms (specific regulations, codes of practice, planning restrictions). EIA should focus on the more local and site specific issues which are not addressed through these more general mechanisms.

Delaying and bureaucratic procedures

In those countries where EIA is applied more consistently to aquaculture development, it is often regarded as a bureaucratic and delaying process, with limited benefit in terms of environmental management. This was especially noted for example in Europe and North America. In many cases EIA and associated permitting procedures can take 2-3 years for new farms or for significant expansion. This serves as a significant barrier to entry and disincentive to invest, especially in those countries where a permit has a relatively short life. Several of the ***Reviews*** note that the delays and inconsistencies are often attributable to lack of integration or agreement between different levels of government or between different departments and agencies.

Effect on the development of the sector

The ***Reviews*** offer very little information relating to the actual effect of these procedures on the development of the aquaculture industry. That which is presented is disturbing. From January 2004 until July 2008, the National System for the Authorization of Aquaculture in Union Waters in Brazil analyzed 1 357 applications with 652 for marine aquaculture and 704 for inland aquaculture projects ***(LA Review).*** By July 2008, only 2 individual proposals (0.01percent) were approved by all authorities involved in the analysis process. This low approval rate demonstrates the enormous difficulty in access to natural resources by small-scale farmers. It also demonstrates that any approval system which is as comprehensive as those commonly associated with EIA is bound to raise concerns from some parties. If the criterion for overall approval is universal approval, very few farms will be approved. Decision-making procedures must be developed that can make acceptable trade-off decisions between legitimate social and environmental concerns, and the need to nurture an important economic activity. In the case of Brazil this is being approached through the development of aquaculture parks, with six such parks already approved.

Lack of capacity to monitor implementation of mitigation and EMP

Several of the ***Reviews*** note a significant lack of capacity and procedures to monitor the implementation of EIA/assessment recommendations in terms of mitigation and management. It is too often seen as a one-off exercise rather than part of a management system. There are exceptions however. Some countries, such as Norway, prescribe an independently audited management system, including environmental management. The Federal Environmental Protection Agency in Mexico undertakes random audits of farms which have been licensed to operate conditional on specified mitigation measures. While we have no data on the success of these approaches, they clearly offer a way of reducing the burden of comprehensive government monitoring and enforcement.

Duplication with standard management procedures

One of the weaknesses of aquaculture EIA is that it often seeks to be comprehensive in terms of coverage of environmental issues. In practice most of the environmental impacts associated with aquaculture are well known, and there are specific regulations or management initiatives in place to deal with these in many countries. On the other hand EIA represents a critical "catch all" which ensures that no serious problems are missed.

Lack of effective feedback into sector management

Several of the ***Reviews*** note the difficulty of gaining access to EIA documents, and there was little evidence of EIA findings being assimilated to inform the development and management of the industry more widely, or indeed to inform other related EIAs. Evidence that the monitoring programmes arising from EIA are used to inform management of the industry was also limited in most countries, though this does appear to take place with respect to the salmon farming industry. In this case however most monitoring is relatively routine, and based on standard models and procedures.

SUMMARY OF THE STRENGTHS AND WEAKNESSES OF EIA

EIA seeks to address a very broad range of issues which have very different characteristics. Some of these are relatively technical and objective: the EIA makes predictions of impact, compares these with established standards, and if necessary identifies mitigation measures to ensure compliance with these standards. Others are much more subjective (social-cultural impacts; landscape etc) and related to local values and conditions. It is worth therefore briefly reviewing the types of issue addressed, and the strengths and weaknesses of EIA in addressing them.

Table 3 summarizes the key environmental issues associated with aquaculture, major characteristics from a management perspective, and the strengths or weaknesses of EIA as a method by which to address them. It also lists possible alternative or complementary methods or approaches which might be more effective, or which might be required to complement EIA. The table is "colour coded" to highlight the areas where EIA is most effective (green) or inadequate (amber/red) with yellow indicating some potential, but usually dependent on other circumstances.

It is clear from Table 3 that while some of the issues of concern can be usefully addressed by EIA – especially if there is a broader management framework - many cannot. It is therefore important that complementary or alternative approaches are in place for these issues, and that time is not repeatedly wasted on individual EIAs. EIA needs to be honed and designed to meet the specific needs of particular countries (and preferably zones) bearing in mind the other tools available, especially in respect of the amber and red rows highlighted above. *Its purpose needs to be clearly stated according to local circumstances.*

EIA in developing countries, and in respect of small-scale developments would be much better used as a simpler positive tool (perhaps used by extension workers) to assist in development of EMPs and mitigation measures – in other words, site specific best practice. It is much less suited as a regulatory assessment tool. It is of particular concern that some countries actually use some of the issues to which EIA is least suited as a trigger for the requirement for EIA. Thus in some countries the possible introduction of alien species may be a trigger for EIA (e.g. United Republic of Tanzania). This will simply reinforce a piecemeal and ill informed response to some major issues which require national level decisions leading to appropriate protocols.

EFFECTIVENESS OF MONITORING

We have already noted that assessment and mitigation is of little value without monitoring. Equally, monitoring is of little value unless it is part of an effective management system. Monitoring data would be much better referred to as *environmental management information*.

> ***"EIA as a single compliance event is of limited use unless it is combined with sustained monitoring. This is generally a weakness in developing countries" (Africa Review)***

The ***Reviews*** reveal both technical and management weaknesses in monitoring, irrespective as to whether it is related to specific EIAs, or is part of a wider environmental management system for the industry. This applies to all regions, but especially Asia,

TABLE 3

Strengths and weaknesses of EIA and alternative approaches in relation to different environmental impacts

The following table is colour coded:
Green: EIA an effective mechanism to address these issues
Yellow: EIA may be effective but depends on contributing factors
Orange: EIA not well placed to address these issues but may complement other mechanisms
Red: EIA ineffective

Issue	Key characteristics	Strengths of EIA	Weakness of EIA	Alternative or complementary measures
Impacts on biodiversity	Site related.	EIA well placed to make useful assessments and mitigation proposals.	Depends on knowledge and awareness of biodiversity values	Local biodiversity policy and/or national biodiversity priorities.
Impacts on landscape	Site related. Subjective, with local, national and technical dimensions	EIA well placed to make useful assessments and mitigation proposals.	Outcome may be unpredictable given the difficulty of generating nationally and locally agreed "standards" for landscapes	Local and national strategic development policy. Decision-making mechanism to balance landscape versus development interests. Design rules for different landscape types or zones. Fish farm free landscape zones.
Social and economic impacts	Site/project related.	EIA well placed to address these issues. Public consultation key requirement.	EIA practitioners rarely trained adequately to address these issues.	Sector studies; local development plans; development proposal/feasibility study.
Waste organic matter	Partly site related. National or local issues and in some cases standards.	EIA well placed to make useful assessments and mitigation proposals so long as standards defined for the waterbody	Effectiveness depends on: understanding assimilative processes in wider waterbody; existence of waterbody standards; and effective monitoring	Ideally nested standards related to different waterbodies and use zones. Environmental capacity estimates for waterbody. Codes of Practice (CoP)
Dissolved nutrients	Partly site related. National or local issues and in some cases standards.	EIA well placed to make useful assessments and mitigation proposals so long as standards defined for the waterbody	Effectiveness depends on: understanding assimilative processes in wider waterbody; existence of waterbody standards; and effective monitoring	Ideally nested standards related to different waterbodies and use zones. Environmental capacity estimates for waterbody. CoP
Chemicals	Site related but with wider implications.	EIA can make useful assessments and mitigation proposals	Effectiveness depends on: understanding assimilative processes in wider waterbody; knowledge of ecotoxicology; and effective monitoring	National standards and protocols for chemical use. Codes of Practice (CoP)
Escapes	Technical issue with local and national dimensions	EIA can make useful assessments and mitigation proposals.	Not cost effective to address this on a case by case basis	Containment standards. National/zonation strategy to minimize conflicts/ contacts with wild stocks
Knowledge, awareness, understanding		Potentially very effective as a tool to raise awareness of opportunities for mitigation.	Usually implemented on a site by site basis and seen as restrictive rather than promotional	
Siting	Technical issue (site suitability criteria). Strategic planning issue. Individual land-use change issue	Detailed practical focus on suitability of a particular site	Although best practice EIA requires consideration of alternative sites, this is rarely feasible. Repetitive process, especially with small-scale developments	Identification of suitable zones or sites for aquaculture as part of more strategic planning. Codes of Practice (CoP).
Sustainable sourcing	National issue – not site related.		EIA inappropriate to address these issues.	National policies or standards. Codes of Practice (CoP). Certification.
Disease	Site specific dimensions but regional, national, international issues.		Not a site specific issue. EIA not well placed to address.	National regulations (reporting; stock movement etc) Monitoring. Codes of Practice (CoP).
Introductions	Local, regional, national and international dimensions		Not a site specific issue. EIA not well placed to address.	National and international agreements and protocols.
General			EIA unsuited to small developments which are likely to grow. Need procedures for allocation of environmental capacity	

Africa and Latin America. While many countries in Europe and North America, as well as Australia and New Zealand may have advanced monitoring regimes, feedback into management and regulation is not always effective. These problems relate to skills and capacity, budgetary limits and lack of effective management frameworks.

Purpose and use

Monitoring does not always have a clear purpose. There is a tendency to require or undertake water quality monitoring as a matter of routine; sometimes this becomes an end in itself rather than a means to improved management – especially of the wider waterbody.

Monitoring as prescribed in EIA and EMPs should be designed to test predictions and the effectiveness of mitigation. It will also typically be required to ensure that the farm is meeting national or EIA determined standards. Again there was little evidence of this from the ***Reviews***. There is even less evidence that such information is fed to the regulatory authorities to supplement their own wider monitoring programmes.

Similarly monitoring of the wider environment by users or regulatory authorities must feedback into management of the whole sector, and other activities which may be contributing to reduced environmental quality. There must be thresholds and response mechanisms. The Viet Nam case offers an example of where a comprehensive monitoring system for the wider "aquaculture" environment can be set up, but where feedback mechanisms to management remain weak. Other ***Reviews*** suggest that government monitoring data relating to the wider environment is effectively used and fed back into management – for example in the case of salmon farming, Europe, Japan, and North America.. In some cases associations with universities are developed encouraging a broader raft of analyses. In Japan some of these relationships – between prefectural stations and universities – have been going for more than 20 years.

Cost and capacity

There is little point in prescribing monitoring regimes if these are beyond the capacity of farmers or others to implement – in terms of cost or skills. In China it was found to be tough or impossible for small farmers to comply with the monitoring required for many certification programmes. In Japan, some of the fisheries cooperative associations find it difficult to meet monitoring requirements, but may be assisted by prefectural services.

Quality

Several of the ***Reviews*** note simple technical inadequacies with monitoring. For example, the Australia review notes that spot sampling of inlet and outlet water may have limited value given daily and seasonal variations. It may also serve as a poor indicator of improved farm performance. Mass balance auditing coupled with periodic local sediment and water quality surveillance may generate better information for performance assessment and management purposes.

Complexity – too many indicators?

Many countries collect data on a large range of indicators, some of which are "auto correlated". There may be potential for reducing the scope of monitoring until very simple indicators suggest there may be cause for concern. At such time more rigorous analysis may be required. In Japan and Norway for example simpler sediment and water quality monitoring regimes are used than in Scotland (United Kingdom). In Japan for example acid volatile sulphide (AVS) is used as the key indicator, whereas in Scotland a much broader suite including video transect survey is used. It is not clear that this generates more useful management information.

ENVIRONMENTAL MANAGEMENT SYSTEMS

Overall, the ***Reviews*** offer rather little evidence on the overall effectiveness of environmental management systems in place in different parts of the world, and in particular the effectiveness of EIA and monitoring. In many cases it is difficult to introduce effective environmental management measures before there are significant environment related problems. Thus in Japan the fisheries cooperative associations tend to be stronger and better organized, and more enthusiastic about environmental management in those areas where environmental and disease problems have already been significant. In areas where eutrophication and red tides have previously occurred, improvements have been made.

> ***Aquaculture-specific legislation allowing for pro-active planning for the industry has "gone a long way to addressing public concerns and improving environmental performance"***

Improvements

SUMMARY OF SUGGESTED IMPROVEMENTS

There was substantial consistency between countries, and between review papers in terms of the needs and opportunities for improvements to EIA and monitoring procedures for aquaculture, although there were also some differences. The following is a synthesis and summary of the many findings and recommendations arising from the review papers and the country reports encompassed within them. It should be emphasized that this is not a *consensus* list. Although many of the following recommendations were repeated across countries and regions, some were specific to particular countries (e.g. Box 4) and not all are perfectly compatible.

Policy and legislation

Legislation is highly developed in many countries, though only in countries with a major aquaculture industry is the legislation usually aquaculture specific.

- Simplify, clarify and streamline the legislation and regulatory framework.
- Strengthen environmental policy implementation at the local level, especially where economic priorities often override environmental concerns.
- Undertake periodic review of regulatory framework to take account of changes in aquaculture, the environment, international commitments and opportunities.
- Strengthen decentralization and participation.
- Strengthen requirements and protocols for effective monitoring, and mechanisms for feedback into management.

BOX 4

Recommendations for a best practice regulatory framework for aquaculture in Australia (PIMC, 2005)

- Integration of policy and clear legislative objectives – the overall objective and responsibility for aquaculture in each jurisdiction needs to be clarified as does the role of relevant agencies and the interrelationship between aquaculture and other planning and environmental instruments;
- Regional planning in line with appropriate planning and land-use principles plan for aquaculture in a pro-active and integrated manner to provide confidence and clarity to industry, government and the community;
- Zoning for aquaculture - areas considered appropriate for aquaculture development should be zoned using planning instruments.
- Transparent and equitable allocation of marine and freshwater resources for aquaculture.
- Leasing – investors need security of tenure.
- Risk assessment and management strategies commensurate with the level of risk (see technical/ scientific aspects below).
- Development consent processes – need to be aligned with other development processes.
- Licensing – should be more adaptive in nature, need for National approach.
- Compliance – licence conditions must be clear and enforceable.
- Environmental management systems (EMS) and eco-efficiency – important for enhancing "clean and green" image of Australia.

- Consider promotion of aquaculture sector specific development strategies and supportive legislation which would facilitate sector specific environmental management systems.

Institutions and capacity

Institutional strengthening was identified as a key issue in nearly all the reviews, and including both developed and developing countries.

- Increase political and industry awareness of the benefits to be derived from better environmental management.
- Clarify institutional responsibilities and procedures.
- Better integrate departments/agencies/levels of government and increase information exchange.
- Assign a greater role for sectoral departments?
- Develop a ”one stop shop” for the farmer to deal with regulatory issues.
- Provide better support and advice for poor farmers – with the emphasis on positive, not negative advice.
- Facilitate organization of small farmers.
- Strengthen planning, monitoring, inspection and enforcement capabilities at local levels.
- Develop regional capacity of regulators and planners.
- Levy aquaculture export revenue to fund support and management systems for aquaculture.
- Ensure budget sufficient to underpin effective implementation of the management framework.
- Promote accreditation of laboratories to ISO 17025.

Planning and management frameworks, standards and limits

The need for better guidelines and standards to streamline EIA and monitoring, and to increase consistency and predictability was raised in nearly all the ***Reviews***. More effective use of risk assessment was also raised in several of the ***Reviews***. Specific recommendations included:

- Develop national and regional aquaculture development councils to bring all parties together to resolve issues and develop agreed strategy.
- Develop regional and sub-regional aquaculture plans.
- Develop spatial planning and zoning, with zone specific objectives and standards.
- Develop locally appropriate and agreed standards and corresponding plans.
- Develop regionally appropriate norms/environmentally precautionary reference points (water quality; exotic species; chemical use; feeds; biosecurity).
- Develop “nested” water quality standards: international, regional (e.g. European, ASEAN); local.
- Develop improved models and procedures for estimation of environmental capacity.
- Reduce uncertainty (for developer/farmer) in the EIA/decision-making process.
- Undertake sector based risk assessment and focus environmental management interventions accordingly.
- Develop more effective monitoring of the wider environment with feedback to sector management.
- Pay attention to threats *to* aquaculture as well as *from* aquaculture.
- Develop guidance, standards and regulation such that EIA is *not* required except in exceptional circumstances.
- Promote greater involvement of stakeholders and farmers in drawing up standards and procedures.

Management tools

Make greater use of economic instruments to encourage sustainable development and compliance with standards.

Permits and licenses

Licensing is widely regarded as the first essential step required to bring aquaculture within an environmental management framework, and is closely associated with environmental assessment and monitoring.

- Introduce licensing for all existing and new aquaculture.
- Streamline licence award procedures.
- Ensure realistic security of tenure to promote investment and sustainable operation.

EIA procedures

- Develop a synthesis document specific to aquaculture based on a review of all EIA guidelines.
- Reserve EIA for high risk projects.
- Use EIA only for largest farms or farms in highly sensitive areas.
- Apply EA in some form to clusters of small farms.
- Develop better/more consistent screening criteria and scoping guidelines.
- Streamline EIA procedures.
- Make sure small producers are not disadvantaged or excluded; minimize barriers to entry of small producers into aquaculture.
- Make EIA fit for purpose – i.e. do not attempt to use it for issues which project level EIA cannot address (e.g. alien species, wider ecosystem effects).
- Undertake better analysis of socio-economic issues.
- Introduce third party assessment/quality control of EIA.
- Certify/train EIA practitioners for aquaculture.

Consultation, information and transparency

Public involvement and better use of information is a recurring issue in all the ***Reviews***. This is far from simple however, and needs to be well managed if it is to do more good than harm.

- Improve awareness of need to consult and involve stakeholders in environmental management, planning and decision-making.
- More efficient and effective public (and *local*) consultation.
- Optimize the timing of public consultation: sufficient information available on which to base consultation; but before the proposal is too well developed to be easily changed.
- Make more use of representative councils to address strategic environmental issues.
- Increase Web-based disclosure and publication of EIA documentation and associated analysis.
- Publish EIA related permitting decisions - clarify the trade-offs made.
- Establish decision processes to address subjective issues: landscape, socio–cultural, access conflicts, etc.

Monitoring

Monitoring is seen as the key to better environmental management in most of the ***Reviews***, though there is always the danger of over-ambition in terms of coverage and parameters. Monitoring without analysis and feedback is largely worthless.

- Introduce effective monitoring of wider environment related to both identified risks and potential management responses.

- Give more attention to effects of other activities *on* aquaculture.
- Pursue an appropriate balance between farm level monitoring, and monitoring of the wider environment.
- Ensure value of information: fewer, more focused parameters?
- Ensure efficient analysis and reporting of monitoring data, and feedback into individual farm or sector management.
- Define and monitor sustainability indicators.
- Establish sampling standards and protocols.
- Make monitoring more locally relevant.
- Create national and regional information systems for aquaculture, drawing on monitoring information.

Analytical tools

A wide range of tools can help with assessment, communication, monitoring and analysis. Several of the ***Reviews*** highlighted opportunities for a greater role for risk analysis to enhance focus in both assessment and monitoring.

- Use risk analysis for screening and scoping in EIA.
- Use risk analysis as part of SEA and sector planning and management initiatives.
- Use risk analysis to inform and focus monitoring programmes.
- Develop environmental capacity models suitable for local and practical application.
- Make more use of simple nutrient budgets.

Awareness and good aquaculture practice

Without heightened awareness of the need for better environmental management and some basic tools to promote it, any government intervention in management of the sector may be resisted and mistrusted.

- Raise awareness, use extension.
- Promote voluntary and market led good aquaculture practice and certification.
- Explore/develop certification programme for aquaculture.
- Promote corporate social responsibility with larger companies.
- Use periodic independent or environment agency audits of management initiatives developed by industry and sectoral agencies.

Technology

Technology can and has had significant success in terms of improving resource use efficiency and reducing pollution, and advances will continue to be made. It is important however not to be over-prescriptive with regard to particular technologies, but rather let farmers adapt in their own way to incentives/pressure from government, regulators and buyers to improve environmental performance.

- Promote ecological/integrated aquaculture where economically viable.
- Promote/develop better waste management and treatment for aquaculture more generally.
- Explore better siting (e.g. offshore aquaculture) to reduce environmental impacts.

MANAGEMENT SYSTEMS

Among the various weaknesses highlighted in the ***Reviews*** three in particular stand out:

- the difficulty of addressing cumulative impacts of many small-scale developments through conventional EIA;
- the lack of environmental objectives and standards – especially suited to the local context;
- the lack of analysis and feedback of monitoring data into sector management.

These are all indicative of a tendency for governments and regulatory authorities to focus on particular techniques (such as EIA, monitoring) rather than on an adaptive management system for the sector. Thus monitoring at farm level is largely pointless in the absence of mechanisms and procedures to analyse the data and use it to further inform the management of the sector.

An effective management system would vary according to national and local conditions but would typically comprise some key elements:

1. understand the values of the system (for aquaculture and for other activities);
2. set objectives, indicators and response/management thresholds to maintain or enhance these values;
3. agree on mechanisms by which to meet the objectives (farm and sector level mitigation);
4. monitor performance in terms of achieving objectives;
5. make corrections to the mechanisms if necessary to meet objectives.

There are examples of such management systems being developed (for example Australia and New Zealand and in some of the salmon producing countries) but they are far from universal.

In conclusion, the specific emphasis on EIA and monitoring only may well have been a distraction. EIA and monitoring are *specific tools* for environmental management, which, in the absence of an overall and effective *management system*, simply become bureaucratic exercises.

EFFECTIVE AND ACCOUNTABLE DECISION-MAKING

Rather little is said in the ***Reviews*** about actual decision-making, beyond the oft repeated issue of lack of standards. However, standards in relation to many of the more subjective environmental issues are very difficult to agree, and in any case have a significant local dimension. We need effective, transparent and accountable decision-making procedures to address the difficult trade-offs which may have to be made in facilitating sustainable aquaculture (and other forms of) development.

This is an area which deserves much more research – mainly on a country by country basis. The ***Reviews*** prepared for this study illustrate the significant variety and complexity of decision-making processes in different countries, and it is very difficult to draw out generic lessons - so much depends on the details of context, history and informal relationships. The key is to build and improve institutions and decision -making procedures so that they:

- are rapid, efficient and cost effective;
- draw on the best available technical knowledge;
- take account of the interests and values of all stakeholders;
- take account of cumulative impacts;
- are consistent – yet responsive to local needs and concerns.

This is a tall order, but should be strived toward nonetheless.

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Most of the material for this global review and synthesis was derived from the *four regional reviews and the salmon review* prepared as part of this project. These in turn are well-supported with references. There are just a few additional key references cited in this synthesis document. The following are referred to directly in the text and/or are considered to be of particular value as guidance for developing effective environmental assessment, monitoring and management systems for aquaculture.

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Review of environmental impact assessment and monitoring in aquaculture in Africa

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ABSTRACT

This section makes an extensive review of the legal and regulatory instruments relating to the application of EIA (Environmental Impact Assessment) in Africa, and of the current state of application of these laws and the practice of EIA in the field of aquaculture. Forty-eight of the fifty-four African countries have enacted environmental laws, most including specific requirements for EIA and 50 percent of these make specific mention of aquaculture. These laws are generally quite recent and in most countries their application is only just beginning. On a continental scale their application in aquaculture is still infrequent. However, both the letter and the spirit of these laws suggest this may change in the future. This presents an opportunity for the countries of Africa to reflect on experience elsewhere and on national objectives, in order to develop an approach to EIA that will benefit aquaculture development in the future.

In particular, the screening and monitoring steps of the EIA process deserve special attention. Good screening procedures including risk assessment can make the imposition of EIA much lighter on the development of aquaculture. Exemptions of installations with low impact and mandatory EIA only for those larger installations with a clear potential for negative impact provides an opportunity for the other projects to be guided during the planning/screening phases towards basic requirements of best aquaculture practice.

Good environmental assessment requires good data. At present this is often insufficient in the regional context and accumulating knowledge about environmental impacts as well as basic environmental data that are important for aquaculture projects will also be a potential benefit of the application of EIA. This emphasises the importance of the monitoring step. In the absence of some data, it may well be more appropriate to approve a project and monitor closely the impact and subsequently adjust practices, than to block the project altogether. Appropriate use of SEA (Strategic Environmental Assessment) would also contribute to facilitating the implementation of project level EIA.

Using EIA as a bureaucratic licensing step should be minimized and the didactic potential of the process emphasised with the input and support of the private sector. Care should be taken to avoid EIA requirements contributing unnecessarily to barriers to entry of new farmers and investors. The use of impact assessment needs the political will to provide the minimum of resources, to ensure the transparency of the process as well as the adequate participation of public stakeholders. There is also scope for greater international cooperation to harmonise the approach between neighbouring countries wherever river basins or other ecosystems cross national boundaries.

CONTENTS

Acronyms and abbreviations

ACCNNR	African Convention on the Conservation of Nature and Natural Resources
AfDB	African Development Bank
AMCEN	African Ministerial Conference on the Environment
ANAF	Aquaculture Network for Africa
BOD	Biological Oxygen Demand
CBD	Convention on Biological Diversity
CPB	Cartagena Protocol on Biodiversity
CCRF	Code of Conduct for Responsible Fisheries
CIANEA	Community Based Impact Assessment Network for Eastern Africa
CIFAA	Committee for Inland Fisheries and Aquaculture in Africa
CITET	Tunis International Centre for Environmental Technologies
CLEAA	Capacity Development and Linkages for Environmental Assessment in Africa
DEAT	Department of Environment Affairs and Tourism (South Africa)
DOA	Department of Agriculture (South Africa)
DWAF	Department of Water Affairs and Forestry (South Africa)
EA	Environmental Assessment
EAA	Ecosystem Approach to Aquaculture
EAAIA	Eastern Africa Association for Impact Assessment
EAP	Environmental Assessment Practitioner
EEAA	Egyptian Environmental Affairs Agency
EIA	Environmental Impact Assessment
EIS	Environment Impact Statement
EMP	Environmental Monitoring Programme or Plan
EQO	Environmental Quality Objectives
ESD	Environmentally Sustainable Development
ESIA	Environmental and Social Impact Assessment
ESMP	Environmental and Social Management Plan
EU	European Union
FAO	Food and Agriculture Organization of the United Nations
FEPA	Federal Environment Protection Agency (Nigeria)
GAPCM	Groupement des Aquaculteurs et Pecheurs de Crevettes de Madagascar
GMO	Genetically Modified Organism
ICB/CBEAPSA	Interim Certification Board/Certification Board of Environmental Assessment Practitioners in South Africa.
IOAEA	Indian Ocean Islands Association for Environmental Assessment
LVFO	Lake Victoria Fisheries Organisation
NACA	Network of Aquaculture Centres in Asia-Pacific
NALO	National Aquaculture Legislation Overview (FAO)
NASO	National Aquaculture Sector Overview (FAO)
NEMA	National Environmental Management Authority (Uganda)
NEMC	National Environment Management Council (Tanzania)
NEPAD	New Partnership for Africa's Development

NESREA	National Environmental Standards and Regulations Enforcement Agency (Nigeria)
NGO	Non-governmental organization
PEA	Preliminary Environmental Assessment (Tanzania)
PEA	Preliminary Environmental Report (Ghana)
PREE	Programme d'Engagement Environnemental or "Environmental Commitment/Responsibility Programme/Plan"
SADC	Southern Africa Development Conference
SACNASP	The South African Council for Natural Scientific Professions
SAIEA	Southern African Institute for Environmental Assessment
SAIEES	The Southern African Institute for Ecologists and Environmental Scientists
SEA	Strategic Environmental Assessment
SEACA	Secretariat for the Environmental Assessment in Central Africa
SIA	Social Impact Assessment
UNEP	United Nations Environment Programme
USA	United States of America
WAAEA	West African Association for Environmental Assessment
WWF	World Wildlife Fund

Summary

Recently enacted Environmental Impact Assessment (EIA[1]) legislation across the African continent comprehensively encompasses aquaculture and this is an important factor for the sector to take on board as implementation and enforcement of these laws increases.

Aquaculture is not as well established in Africa as elsewhere and EIA regulations are still being refined, which indicates an opportunity for the sector to work with environmental authorities to innovate and to further develop appropriate Environmental Assessment (EA[1]) mechanisms for aquaculture.

There are opportunities to emphasize a didactic and enlightening role for EA/EIA with the goal of influencing farmers to improve the sustainability of aquaculture practices in Africa, while reducing the need for extensive and repetitive EA studies and enforcement.

At the present level of aquaculture development, African countries should consider opportunities for strategic studies using Strategic Environmental Assessment (SEA[1]) for the sector rather than relying only on project-level environment impact regulations. Extending the assessment boundaries in this way will provide the information needed for good strategic planning (such as zoning decisions), as well as environmental information vital for the planning of individual projects. Successful SEA should make project-level EIA more efficient and less onerous.

The platform of EA can serve to guide aquaculture in Africa towards sustainable and ultimately more beneficial options. There are many aspects of integration of aquaculture with other agricultural activities which bring potential environmental benefits and these can be promoted to counter some of the negative perceptions of aquaculture in this regard.

Africa is fortunate in possessing many relatively unpolluted aquatic ecosystems. There are opportunities for using EA processes that can confirm the adoption of environmentally friendly aquaculture methods, to achieve added value in the marketing of aquaculture products from Africa's pristine environments. The feasibility of this is being demonstrated by initiatives in Madagascar and Zimbabwe to access premium export markets.

Biodiversity is a critical element. EIA for alien introduction needs clarification. Given the uncertainty of predicting the impact of an introduction, opportunities should be taken for effective application of risk assessment and management and for adapting up-to-date technologies to local species.

The key stages in the EIA process for aquaculture in its present stage of development are *screening* and *monitoring*, rather than in universal in-depth environmental impact studies. Screening, focussed mainly on a few significant parameters, is needed to identify high-risk proposals. Effective monitoring is probably the most valuable part of the EA process to Africa at present, needed to provide the missing information on real-life impacts and ensure this feeds back into the process, thereby improving planning and screening and future EA.

EIA is most obviously applied to large-scale intensive enterprises. However, small and medium scale farmers will be important to the future and the EA processes need to be adapted to their reality. This could be with a simple field "check-list" type

[1] EA: Environmental Assessment (general)
EIA: Environmental Impact Assessment (project-level regulatory obligation)
SEA: Strategic Environmental Assessment (strategy at national, regional or waterbody level)

appraisal, or it could simply be by exemption. Eventually the sector needs to consider a mechanism to deal with aggregated impacts from multiple small farms. Fixing reasonable thresholds at which EA becomes necessary, appropriate to each national context, makes the EIA process more "workable".

It will be important that care is taken to avoid EIA contributing unnecessarily to barriers to the entry of new farmers and investors. Cost, risk and lack of information about environmental impact are all restraining factors that need to be constantly reviewed. It is also important that countries do not weigh down future development with excessive regulation of which EIA is a part; investors must be given enough freedom to develop the sector. This is another reason to emphasize the screening stage (to filter out for further study only those proposals with obvious risk to the environment) and the monitoring stage (to gather data on real problems as they occur) as being the parts of the process that need most effort at present.

Public participation is an important element of a successful EIA and there is a lot still to be done to convince government authorities and investors of possible benefits of appropriate public participation.

EA considerations in general and stakeholder consultation in particular, will bring greater benefits and less opposition if applied earlier in the project planning sequence.

Knowledge and data about the environment and about alternative aquaculture options is very incomplete at present. Accumulating this information and making it openly available to new entrants should be an active priority for both the public and private sectors together. EIA studies and the conclusions of project monitoring, should be in the public domain and contribute to this national database.

Enacting the legislation is only the beginning for the national bodies responsible for the environment. Overseeing the EIA system requires substantial competent staff resources to successfully review the different documents produced throughout the process, critically interpret the technical data in the environmental impact statement (EIS), take appropriate note of public concerns and finally take an important decision on complicated evidence. The national capacities required fall short of requirements at present and building these up is recognized as being a priority.

The sector must be aware of the risks to the integrity of EIAs. Two to note are (a) the partiality of EIA studies led by project proponents in the absence of robust oversight and (b) the reduction of the process to a paper-based bureaucratic authorization exercise bringing delay and inefficiency to efforts to develop aquaculture.

None of this can make any progress without substantial political will. Both public and private sectors will gain from active engagement in this environmental debate in order to put the case for aquaculture growth.

International and regional cooperation over EA has a number of benefits. Coordination of appropriate articles of the legislation will make it easier to deal with the transboundary impacts that can occur through the ecosystem. Sharing of experiences and expertise in this field can compensate for some of the shortfalls in current national capacities.

Presentation of this study

This study is one of four regional studies reviewing environmental impact assessment practice in aquaculture across the globe. The aim is to review the requirements for EIA and monitoring, describe the practices and to appraise the effectiveness of procedures that are in place. Given that there is limited experience in Africa in both aquaculture and EIA, the document attempts to describe the evolving situation bringing these two activities together.

The section is in three main parts. First, a broad review of the key issues confronting African aquaculture stakeholders, as they seek to intensify the development of aquaculture, against a background of increasing concerns for the natural environment. A second part presents case studies of the situation in six countries from across the continent. The final part attempts to analyse the impact of current arrangements and discuss the efficacy of some of the new EA initiatives being applied to aquaculture.

Introduction

As awareness of the importance of environmental issues has grown across the world over recent decades, efforts to manage and mitigate man's impact on the environment have intensified. The need to establish methods for measuring the potential for negative impacts on the environment, and to enshrine these in statutes, was first felt in the United States of America (USA) and Europe where it became necessary to manage the choices being made in the way new technologies were applied. Environmental Impact Assessment (EIA[2]) has been a central component of these statutes, and this was made a mandatory process for most large-scale developments. It is a process that is proving useful for aquaculture, a sector which has been seen to have created some significant environmental problems in the course of its recent rapid global development.

More recently, African legislators have also found it necessary to take steps to regulate in a similar manner as pressures on the environment increase as a result of increasing population, economic development, urban growth and other factors. It has also been necessary to mirror regulation elsewhere in order to avoid the displacement of environmentally damaging developments away from regions with stricter laws. EIA regulations are a part of these new legal frameworks and already over 75 percent of African countries have passed specific statutes relating to EIA. Over half of these have only been passed into law in the past five years and are yet to be tested in many situations.

Aquaculture is a sector that has seen extraordinary global growth over the past decade, and Africa certainly has the resources to contribute significantly to this growth in the future. However, this is still largely a development waiting to happen and Africa only contributes about 1 percent of world production (Hecht *et al*., 2006; FAO Fisheries Department, 2006; see bibliography for FAO National Aquaculture Sector Overviews in Africa).

Considering that the legal frameworks are still maturing, and the number of new developments in aquaculture is still small, this review focuses on some of the options that are available to making EIA relevant to the future of aquaculture in Africa. A small number of EIA studies have been carried out for individual aquaculture projects, but many of these have not been done as part of national legal requirements, but rather at the request of external investing institutions. These few experiences do not follow a set pattern and could not form the basis of a continent wide analysis, although the country case studies presented here provide some lessons that could be of relevance elsewhere.

[2] The acronyms EIA and EA are freely used in this text. EIA refers to the legal process of Environmental Impact Assessment, while EA refers to Environmental Assessment in a more generic sense.

Summary of issues surrounding EIA and aquaculture

INCREASED AWARENESS OF ENVIRONMENTAL ISSUES

EIA is a process that has evolved out of growing global awareness of the importance of the environment in making both local and strategic decisions about almost any human activity. Africa shares these concerns, although it has been manifested more recently in the institutions and legislation. The Abuja Declaration made in 2005 by African Union leaders clearly states that although aquaculture development is a continental priority, it should be sustainable and environmentally friendly (NEPAD, 2005):

"Foster small, medium and large-scale aquaculture production in a sustainable and environment-friendly manner … Conserve aquatic environments and habitats essential to living aquatic resources and aquatic biodiversity; and take measures to prevent or mitigate adverse impacts of aquaculture on the aquatic and coastal environment and communities"

It is activities with an obvious potential for negative impact, such as oil drilling, mining or urban development that spring quickly to mind when considering the importance of making an environmental assessment, but it is now widely recognized that precautionary assessment is also necessary for activities previously perceived as relatively benign, such as agriculture or aquaculture. Aquaculture, in particular, is very closely linked with the wider natural environment and this is illustrated by its dependence on good quality water sources, as well as by its potential to have negative impacts on that resource downstream.

There is a question over how the scope of the "environment" is perceived from different viewpoints and how this affects the assessment of aquaculture, as it does for other activities. For some the situation to be assessed refers to a simple interaction of a fish farm with local environmental parameters "at the farm gate"; essentially an approach for "pollution control". For others it refers to the wider ecosystem and aims for a holistic assessment of the interaction between aquaculture and many levels of its surroundings - physical, social and economic. In Africa, some of these differences over the definition of environment can be seen in the philosophy and wording of particular national legislation, while in other cases it reflects the level of knowledge about, and commitment to the EIA process. In general, however, there seems to be a tendency to move towards assessment of the impacts on the environment in its wider sense.

Since the origins of increased legislation and the push to better management of the environment has largely been from outside the continent, this does give Africa the opportunity to learn lessons from experiences of success and failure elsewhere. It is mostly true to say that environmental law and institutions have not often been primarily created in response to domestic public pressure or concern for the environment. However, this is changing and there is now a greater sense of urgency over environmental issues among both the public and national institutions in Africa. This is very important for the future application of EIA in all sectors, including aquaculture. A new domestic environmental activism will contribute enormously to the definition of the standards of what is acceptable or not to local/national society/ communities, not only in relation to the natural environment (e.g. pollution, habitat loss) but especially in terms of impact on social and economic parameters. Without such reference points established in a local context, it is difficult for processes such as EIA to be fully effective in the decision making process. While transferring external or "international" standards can be a useful starting point for typical physical and chemical factors in the environment, it is not appropriate when applied to impacts on factors where national and regional conditions have to be taken into account.

We now know a good deal about the potential of aquaculture development to impact on the natural and human environment, and although much of this information comes from outside of the continent it is available to be applied with care to African situations.

NATURE OF ENVIRONMENTAL IMPACTS LINKED TO AQUACULTURE

While some of the national legislation relating to environmental impact does contain references to aquaculture, even occasionally citing specific potential impacts, there is always the likelihood of an aquaculture project being required to conduct EIA under the generic definition of projects that "are expected to have a significant impact". Experience has shown both globally and on the continent, that aquaculture can have a number of impacts on the environment as summarised in Table 1.

TABLE 1
Environmental costs and benefits of aquaculture

Negative environmental impacts of irresponsible aquaculture	Environmental benefits from responsible aquaculture
• Loss or degradation of habitats such as mangrove systems; • Salinization of soil and water; • Coastal and freshwater pollution; for example, contamination of water and fauna through misuse of chemicals and antibiotics; • Alteration of local food webs and ecology; • Alteration of catchment water flows; • Depletion of wild resources and biodiversity for seed or broodstock; • Spread of parasites and diseases to wild stocks; • Depletion of wild genetic resources through interactions between wild populations and cultured populations; • Impacts of introduction of exotics (deliberate or inadvertent).	• Agricultural and human waste treatment; • Water treatment and recycling; • Nutrient sink; • Pest control; • Weed control; • Disease vector control; • Desalinization of sodic lands; • Recovery of depleted wild stocks; • Preservation of wetland.

Source: World Bank, 2006.

These impacts can be negative, but also sometimes positive, and are usually only critical when the farms are particularly large or there is a local concentration of smaller units. It is also necessary to realize that the sustainability of aquaculture depends greatly on the quality of environmental factors "upstream" of the farm. Many unrelated activities can have a negative impact on these and an assessment for an aquaculture installation would only be complete if it also looks at risks from this "other direction". While most environmental legislation covering environmental assessment tends to focus on potential negative impact "downstream" of the activity, a few recent statutes, such as Ghana's fisheries law, have taken a "defensive" sectoral view seeking to limit "upstream" negative impacts on aquaculture (Ghana, 2002).

Clearly the interactions between aquaculture, the environment and other elements of the ecosystem are complex and impact both "from" and "on" the activity can be summarised as follows:

Potential impact of aquaculture on the natural environment

Recent growth in aquaculture has, not surprisingly, had a mixed record with the environment. In the early stages of the recent rapid global expansion of aquaculture there have been cases where massive growth, coupled with ill-informed management practices have become notorious examples of cause of undesirable environmental impact. In most cases, significant strides have been made in improving these situations and better knowledge and practice are changing the negative perception that aquaculture had been given in certain quarters. Interestingly, Africa has benefited from these improvements and is in the vanguard of efforts to demonstrate that aquaculture can be effectively managed in environmental terms. This is illustrated by African developments in at least two of the most notorious problem areas for aquaculture of the past decade – shrimp culture in mangroves (Madagascar) and cage culture (Zambia, Zimbabwe).

Downstream impacts of aquaculture on the natural environment that would normally be considered as carrying a risk and may need to be included in environmental assessment include the following:

Water quality, including:

- altered physico-chemical characteristics in farm structures (such as ponds) and in water released as effluent back into natural water courses, waterbodies, drinking water supplies;
- release of chemicals used in veterinary treatments into aquatic systems;
- release of suspended organic material, usually from fish feed and faeces, into aquatic systems, altering ecosystem characteristics and carrying risk of eutrophication.

Water quantity

- in a situation where water is a limited resource aquaculture consumes water; for example where increased surface area increases evaporation and water seepage into soil;
- alteration of flow patterns, impacting other users and natural systems (tidal flows in coastal infrastructure, stream flows or lake/sea current);
- influence on underground water flows e.g. springs which can be important to small-scale rural agriculture.

Space

Sensitive habitat

- irreversible destruction of sensitive habitats such as mangrove or inland wetland;
- alteration to natural ecological processes in sensitive habitat in proximity to aquaculture installations.

Impact on biodiversity in the ecosystem

There are potential consequences for ecosystem biodiversity that can occur as a result of any of the above mentioned possible impacts that might be caused by aquaculture. The resulting ecosystem changes could, for example, affect the distribution of local species (plant, animal, micro-organisms) some of which may be of economic importance.

Often a major concern is for the impact a cultured organism may have on the natural biodiversity of the region (Halwart and Moehl, 2004). If the aquaculture species used is alien to the region there will be significant risks to local biodiversity should it escape into the wild, something that is particularly difficult to prevent. In other cases there may be some concern about a domesticated strain of a local species with different selected characteristics to the wild population (which may support important fisheries) or about use of genetically modified organisms (GMOs).

Potential sources of impact from the environment on aquaculture

It is necessary to include consideration of the environmental relationships between aquaculture and "upstream" factors (Calamari and Naeve, 1994). While these may not always seem to be a priority in EIA regulation, they are closely interlinked with the overall picture and will affect the capacity of the aquaculture installation to control its own "downstream" impacts.

Important "upstream" influences include:

Quantitative changes in water resources

- flow reduced by upstream consumers;
- flow patterns changed by dam construction.

Upstream terrestrial activity

- soil erosion/degradation can affect sediment loading and hence productivity (based on primary production) and can be caused by far distant activities of many kinds;
- severe qualitative variations such as mining, introducing heavy metals into the aquatic system.

Agricultural, urban or industrial runoff/pollution

- very often aquaculture is present in areas of multiple agricultural activity. Many agricultural activities can affect aquaculture downstream; impacts include variations in water run-off from the cultivated land, and washing of fertilizer and chemicals into the water flowing downstream. Many of these show seasonal variations, and some are very short lived events, which need to be planned for in aquaculture management.

Positive or neutral environmental impact

It is not all bad news and aquaculture in many of its forms is not inherently damaging to the environment, not least because the fish need to be raised in conditions at least equivalent in quality to their own natural environment. Good environmental management is in the self-interest of the farmer and needs to be incorporated into generally accepted "best practice" within the sector.

In Africa, aquaculture has demonstrated its capacity to contribute to sustainable use of ecosystems through enhancing or combining with other productive activities, such as fisheries (e.g. aquaculture-based fisheries), agriculture (e.g. rice–fish farming) and animal husbandry (e.g. pig/poultry–fish farming). These culture systems can contribute positively to environmental improvement by recycling nutrients and organic matter through integrated farming systems. Integrated aquaculture–agriculture practices have shown how rice–fish culture can help farmers reduce the use of environmentally damaging pesticides, while fish culture naturally improves the fertilization of rice fields, protein production and economic viability. Wastewater-fed freshwater aquaculture and coastal mollusc and seaweed farming can be used to recover excess nutrients, thereby reducing risks of eutrophication and other negative effects. In Egypt extensive fish-culture has long been a part of traditional agricultural practice, because when carried out on certain types of unproductive land common in the Nile delta, it can improve the quality of soil that is subsequently used for cropping.

Not only are these benefits key to promoting a more positive image of aquaculture in some quarters, but they need to be highlighted in the EIA process as valuable actions mitigating negative environmental impact from other sources.

Interaction between aquaculture production units

There are specific risks that can occur as a result of the proximity of other similar aquaculture farms. As well as the general competition for land and water resources, the most specific risk is from the transmission of disease between farm stocks and the consequent increased risk of contamination of wild populations.

Questions of scale, aggregation of small impacts

Isolated aquaculture farms of the types most common now in Africa will rarely have more than limited local environmental impact. Two general scenarios can occur where there may be heightened concerns for potential negative impacts on the environment.

The first is for the big commercial farms, which due to their large scale may carry greater risk of negative impact that can be magnified by adopting highly intensive management options. Nevertheless, commercial aquaculture has access to technologies that can mitigate these risks. It is for this category of farm that EIA is most obviously needed and has most often been applied in Africa.

The second scenario occurs with a geographical concentration of small-scale aquaculture farms, which individually may not be considered of great environmental risk. However, if the activity is successful and profitable, a large number may spring up in close proximity and the resulting aggregation of minor impacts can be expected to cause problems at least as great as a single large commercial farm. EIA procedures are less easily applied to this situation: individually the small farms may not fall under EIA obligations and may have no problem in meeting normal standards. An adapted procedure would have to be developed to deal with the aggregated impact of many individual farms.

CROSS CUTTING ISSUES

Grouped under the description of "cross cutting" issues are the many possible impacts that can be expected when considering the wider environment beyond the immediate natural environmental parameters summarised above. The extent to which these are actually expected to be included in an EIA study varies with the legislation in different countries. However, as aquaculture in Africa develops and grows, decision-making processes will need to include assessment of more and more of these wider but interlinked issues.

These include social and economic dimensions and the ways in which resources are shared. Equitable sharing of resources can be an important issue with environmental ramifications and is sometimes a difficult issue to master in Africa when unfamiliar commercial/industrial imperatives disturb a predominantly traditional approach.

Land tenure, access to land resources

Land tenure practice varies considerably across Africa. It is not only an issue of ownership, but also frequently of traditional communal or community access to land for various essential uses. Creating aquaculture infrastructure can disturb the local equilibrium of land access and use.

If a country wishes to promote the development of commercial aquaculture it is necessary to provide investors willing to invest in these types of activity with sufficient long-term security of occupation, especially where outright purchase of land is not possible. At the same time it will be wise to ensure that local communities are not deprived of the resources and the ecological services of the land on which they depend.

Water rights, access to water resources

Across the continent, Africa has a wide variation in availability of water resources. However, even in areas of relative plenty, there can easily be competition for these resources that are required for agriculture, irrigation, livestock, domestic use, town supply and industry. Estimating the potential for sustainable use has to include all sectors including aquaculture and needs to recognise the wide seasonal variations that are experienced in many parts of Africa. Aquaculture investors need to have some kind of security of access to water, something that is not always easy to obtain if legal frameworks do not exist, do not recognize the needs of aquaculture or are not enforceable.

Impact on capture fisheries

Aquaculture development has the potential to affect capture fisheries in several ways:

- reducing the recruitment of juveniles into the fished population where wild seed are harvested for stocking aquaculture – such as the use of brackish water species (mullets) in Egypt;
- creating a source of disease which can be transmitted to wild populations;
- biodiversity impacts from escapees of alien or domesticated strains – as in Madagascar where most inland fisheries are now dominated by introduced species;
- problems with navigation, occupation of space;
- competition in the marketplace with capture fishery products.

Human health

Human health issues can arise including water borne diseases like bilharzia, or indirect impacts such as spread of HIV/AIDS as a result of demographic changes that might occur as a consequence of development of a successful aquaculture industry.

Gender participation

Impacts from aquaculture might not be felt in the same way by both genders within a local community, especially in a rural environment where, for example, women may lose access to key resources such as firewood, or fishermen may face changes to their traditional activities. Comprehensive EIA approaches would take these issues into consideration when consulting community stakeholders.

Economics, poverty

Aquaculture development is encouraged with the objective of increasing production and economic activity, with the promise of jobs and other benefits. This may raise further questions of impact. Does it actually reduce local poverty, or does it risk increasing poverty by disturbing established local economic activities? Does aquaculture displace alternative agricultural activities and at what cost?

Impact of supply and distribution

As the aquaculture sector grows in a country or region, there will be concerns for the additional impact of expanded industrial or agricultural development that accompany the increase in aquaculture enterprises. These activities include the supply of inputs and services, as well as the increased infrastructure needed for the distribution, storage and marketing of its products. Some of these additional impacts should be included in project EIA studies for individual large commercial farms, but in many cases it is difficult to control this "bigger picture" from a project level perspective.

One of the major issues is that of feed used in aquaculture. In some cases the feed required has to be of very high quality and include significant proportions of fish meal. Often, as in the case of Madagascar, it has to be imported raising questions of economics. In Africa there will also be concerns when using locally produced ingredients that there are difficult decisions to be made about channelling a country's agricultural endowment or capacity to produce fish feed, rather than using it directly for food production for local consumption, especially when the fish products are destined for export.

BIODIVERSITY

Questions over the impacts that can occur on the biological diversity of an area as a result of aquaculture activities are often high on the agenda when undertaking environmental assessment. As indicated above there are many possible effects that aquaculture can have on its physical surroundings which can in turn affect natural populations of animals and plants and their diversity. However, the key issue is that of the introduction of alien species for aquaculture. These can escape and change the composition of the indigenous ichthyofauna. This has an international dimension as there are many situations where there is a risk of transboundary impact across aquatic ecosystems and major river basins.

The concern is not only for the survival of indigenous species. Changes in fish biodiversity can have significant knock-on effects and cause social and economic upheaval whenever capture fisheries are affected. This is very much a live issue in Africa as the fisheries in Lake Victoria continue to be subjected to the consequences of the introduction of Nile perch (*Lates niloticus*) into the lake system. Another risk comes from the possibility of importation of disease vectors along with the introduced species.

Pressure to introduce alien species often comes from investors in aquaculture who see the immediate advantages of importing a species as part of a proven technology or with the attraction of a known viable export market. Research into the use of local species is seen only as a long-term option, if it is considered at all.

National environmental law in Africa, including EIA regulations, is often specific in mentioning species introductions as being subject to prohibition or to strict control and only approved under exceptional circumstances. The African Union (African Union, 2003) has added political weight to this position and stated that member countries should:

"strictly control the intentional and, in as far as possible, accidental introduction, in any area, of species which are not native to that area, including modified organisms, and endeavour to eradicate those already introduced where the consequences are detrimental to native species or to the environment in general".

This commitment is further confirmed by the adhesion of most African countries to international agreements or codes of conduct that also seek to establish a precautionary approach to the use of alien species. These include the Convention on Biological Diversity[3] (CBD) and the FAO Code of Conduct for Responsible Fisheries[4] (CCRF). The CBD defines biodiversity at three different levels - ecosystem, species and genotype – and suggests that EIA is one of the appropriate tools for the conservation of biological diversity. At each of these three levels aquaculture in Africa has already raised concerns and these would be expected to be taken up as part of the EIA process.

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[3] The Convention on Biological Diversity (CBD, 1992): The introduction of alien species into ecosystems has the potential to adversely affect biological diversity. The Convention on Biological Diversity, an international agreement with 182 member countries including 53 in Africa, requires parties to prevent the introduction, control or eradication of those alien species that threaten ecosystems, habitats or species. The parties to the Convention have developed guiding principles for the prevention, introduction and mitigation of impacts of alien species, which are an important guide for managing species introductions. The Convention also addresses the more specific issue of biosafety, referring to the need to protect the environment and human health from the possible adverse effects of organisms that are modified using techniques of modern biotechnology. The parties to the Convention developed and adopted an agreement on biosafety, known as the Cartagena Protocol on Biosafety, aimed at ensuring an adequate level of protection in the safe transfer, handling and use of living modified organisms resulting from modern biotechnology. (www.cbd.int/convention/convention.shtml)

[4] FAO Code of Conduct for Responsible Fisheries (FAO, 1995): Fisheries, including aquaculture, provide a vital source of food, employment, recreation, trade and economic well-being for people throughout the world, both for present and future generations and should therefore be conducted in a responsible manner. This Code sets out principles and international standards of behaviour for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. The Code recognizes the nutritional, economic, social, environmental and cultural importance of fisheries and the interests of all those concerned with the fishery sector. The Code takes into account the biological characteristics of the resources and their environment and the interests of consumers and other users. States and all those involved in fisheries are encouraged to apply the Code and give effect to it
"9.1.1 States should establish, maintain and develop an appropriate legal and administrative framework which facilitates the development of responsible aquaculture." CCRF, Article 9
(ftp://ftp.fao.org/docrep/fao/005/v9878e/v9878e00.pdf)

Given this regulatory background and the obvious risks that exotic introductions involve, the question of using an introduced species must obviously be included in the studies and recommendations when carrying out an EIA for a project. However, given the lack of control over the consequences of an introduced species establishing itself in the wild and the irreversible nature of the impact on biodiversity once it has occurred, it is difficult to see to what extent a project EIA can satisfy the precautionary constraint that the legislation requires. Mitigation measures can be proposed to minimize escape from the project, but this cannot be guaranteed and experience would question whether it could ever be possible to do so. There are exceptions, such as for species which are proven to be unable to reproduce in the new local conditions.

AFRICAN EXPERIENCE OF ENVIRONMENTAL IMPACTS FROM AQUACULTURE

Despite the fact that aquaculture in Africa is relatively undeveloped when compared to some regions and that the most notorious incidents of negative impacts have occurred elsewhere, there have been some salutary experiences already in Africa that illustrate actual environmental impact, or at least the perception among various stakeholders of a potential for negative impact.

The most widely registered impact has been the use of exotic species that have escaped from aquaculture installations and become established in the wild outside of their natural range, sometimes with disastrous consequences on local species and habitat (Moehl *et al.*, 2006). There is not sufficient background research into the consequences of these introductions to apprehend their overall impact on biodiversity, although in some cases the introduced species now contribute to economic capture fisheries. Not all introductions for aquaculture involve fish or other organisms from outside Africa; there are many instances of the movement of African species for the purpose of aquaculture across the continent outside of their natural range, e.g. *Tilapia* sp., *Clarias* sp., *Heterotis*. Madagascar has had a particularly dramatic experience of introductions into its freshwater habitats and counts at least 29 alien fish species (FishBase, 2008). These alien species have come to dominate the ichthyofauna in many of the island's aquatic systems, and are now very important in some fisheries. At the same time 26 Malagasy endemic freshwater species are classified as threatened. While this may not entirely be attributable to the presence of aliens, it seems likely that this is a major factor.

Other cases indicate a growing awareness of the potential impacts that large-scale aquaculture can have, prompted by the realisation that similar projects elsewhere have had negative effects on the environment. The following incidents have highlighted the usefulness of the EIA process to both the public and the authorities and they seem to have set a precedent for aquaculture projects in the countries concerned:

- campaigning brought a large initial proposal for shrimp culture in the Rufiji Delta in the United Republic of Tanzania to a halt, partly based on perceptions of the negative impact on communities and ecosystems of shrimp farming in South and Southeast Asia. Shrimp culture can be an economic force leading to excessive destruction of mangrove forest habitat and disruption to local fisheries and communities, and it was feared this could happen in the Tanzanian context, despite significant political support for the proposal.
- the potential of cage cultures to pollute the water and benthos around them has received a lot of coverage in the media. In Zambia, some small-scale trials of cage farming in Lake Kariba provoked a sharp response from the environmental authorities who reacted to local objections and felt that the reputed risks associated with cage farming were sufficient to justify a temporary stop to the trials. Environmental assessment is now undertaken for similar activities (see Box 1).

Other examples where aquaculture has raised diverse environmental concerns on the continent include cage farming in the river Nile in Egypt, the use of chemicals by some catfish farmers in Nigeria, or the installation of ocean cages in a popular tourist location for shark watching in South Africa. Elsewhere impacts will have been localised, or contained within acceptable limits as a result of the use of preliminary environmental assessment as in Madagascar, Mozambique or South Africa.

Shrimp farming has a high profile and it has been of particular significance to early implementation of EA in Africa. This is an aquaculture practice that has attracted a significant amount of criticism for its environmental impacts and created many problems for itself when unsustainable methods have been used. Lessons have been learnt from this, and one of these is the need for good EA (including strict regulation) to ensure that short-term profit motives do not lead to wholesale negative impacts on the environment. In Africa there have been a number of important investments across the continent including:

- Gambia (project which failed after encountering environmental problems now operating again using more sustainable methods);
- Guinea (Sakoba project, the failure of which is in part attributed to inadequate environmental assessment);
- Madagascar (successfully established after putting the environment as a central concern of the operations)
- The United Republic of Tanzania (early proposal rejected for its potential negative impacts, new projects now operating after implementing new environmental regulations).

BOX 1

Sunday Times of Zambia report on cages in Lake Kariba 2004

Ban cage Fishing – Farmers

By Sunday Times Reporter

FISH farmers on Lake Kariba in Siavonga district have alleged that the newly introduced fishing method known as "cage culture" is blocking their full access to the lake.

The farmers have called for an immediate ban on the method.

"The cage culture method entails aligning huge reed baskets along a large area on the banks of the lake thereby restricting people's movements into the water.

Speaking for local fishermen in during the week, Edward Habeenzu said apart from introducing unknown chemicals in the lake, the cages were a hindrance because they were blocking easy access to the lake.

He condemned the Environmental Council of Zambia's (ECZ) decision to merely fine the cage culture farmers and allow them to continue exploiting the lake using the new methods before it could complete its environmental impact assessment.

"The problem we have in Zambia is that we allow experiments to be undertaken by business people whose aim is to convince you that what they are doing has no negative results to the environment before finishing our own investigation," he said.

ECZ education officer Justin Mukosa said it was too early to impose a ban on cage culture because his organisation was still carrying out investigations.

He said the basic findings on the impact of an alien species of fish called tilapia (bream) that had been illegally introduced in Lake Kariba indicated that potassium permanganet was being used to protect the caged fish against fungal diseases.

Meanwhile, the ECZ has fined the three fish farmers using cage culture and ordered them to conduct individuals environmental impact assessment on the Zambian side to determine the safety of their fishing method on the lake.

The institutional and regulatory framework for EIA in Africa

FIFTEEN YEARS OF EVOLVING ENVIRONMENTAL PROTECTION LAW

The past 15 years have seen a rapid change in environmental law frameworks in response to changing perceptions on the part of governments and civil society; over the same period there has been growing concern about the environmental impacts of aquaculture activities (Spreij, 2004). New environment laws have been passed in most African countries (see Table 2 and Box 2 for a summary of laws identified by this study). Many of these are so recent they do not yet have a significant history of application or enforcement, particularly in aquaculture and fisheries. This applies equally to the anglophone, francophone and lusophone countries although the literature on this subject is primarily in English (Almeida, 2001).

Specific EIA enabling regulations have also been created in the majority of African states as part of this process (see Table 2), although they are not so widespread and take various legal forms. Some framework laws go as far as including detailed articles concerning EIA in the main law, whereas in most instances provision is made in the law for subsidiary legislation to define the detailed obligations and procedures for EIA. These vary greatly in content: some do not specifically mention aquaculture, which would be included in a general category as an "activity" requiring EIA if it is expected to have a significant impact on the environment; others specifically mention aquaculture, and if not requiring EIA for all projects, go on to define exactly the size threshold of aquaculture projects that must carry out the full process.

The genesis of many of these laws is of interest. International banks and bilateral aid donors put pressure on countries through the 1990s to enact environmental framework law. Many were authored with external assistance and modelled to some degree on European and North American precedents. As a result many countries went rapidly from a situation of weak environmental legislation to one of strong or even draconian legislation. In most cases this occurred in the absence of urgent domestic pressure and without many civil servants, the private sector

BOX 2

In figures: legislation in Africa relating to EIA and aquaculture

A survey of the legislation of 54 countries in Africa, possibly incomplete because some legislative texts are hard to obtain, revealed that aquaculture is significantly affected by regulations covering environmental management and more specifically EIA:

- 48 *(89 percent)* countries have already enacted framework environmental laws;
- 40 *(75 percent)* countries have enacted detailed EIA regulations;
- these EIA regulations are relatively recent and 31 *(78 percent of EIA regulations)* have been passed in the past ten years, and 21 *(53 percent)* in only the past five years;
- 20 *(50 percent)* of these EIA regulations make explicit reference to the requirements for aquaculture; this increases to 28 *(70 percent)* if references to related infrastructure are included (e.g. reservoirs, canals);
- 16 countries with EIA regulations specifically mention the introduction of alien species as requiring EIA *(40 percent)*;
- at least 24 countries have published detailed guidelines for implementing EIA *(60 percent of EIA regulations)*;
- four countries have produced specific guidelines for aquaculture;
- 11 *(20 percent)* countries have included Strategic Environmental Assessment (SEA) in either the framework or the EIA regulations.

Source: analysis of the documentation summarized in Table 2.

TABLE 2
Summary of environmental law and EIA regulations affecting aquaculture in Africa (to 2006)

Parties to relevant international treaties: Convention on Biological Diversity (CBD); Cartagena Protocol on Biosafety (CPB); African Convention on the Conservation of Nature and Natural Resources (ACCNNR). Y = yes; N = no.

Country	Environment Law	EIA Regulations	CBD CPB ACCNNR	Explicit mention of aquaculture in EIA regulations	Explicit mention of EIA regarding introduction of alien species	EIA Oversight Institution	Guidelines published for EIA: general or aquaculture	Explicit SEA/SIA provision
Algeria	2003	1990	YYY	Aquaculture and mariculture is **excluded** from the EIA regulations. Mention made in fisheries law a requirement for "an evaluation of the consequences of implanting a project on the environment" as part of a licencing process		DGE	General guidelines	No
Angola	Environment Framework Act 1998	(2001)	YNN					No
Benin	1999 Framework Law on Environment 98-030	2001	YYY	Simplified EIA mandatory for aquaculture / fish culture	"The laws and regulations determine the conditions for the introduction, from whatever source, of any species which might have an impact on existing species or on their natural habitat..."	ABE/BEA	General guidelines	No
Botswana		2005	YYY			DEA	General guidelines	Yes
Burkina Faso	1997 Law on Environmental Code 005/97	2001	YYY	Category A (requires EIA): dams over 10m height Category B (requires a notice of impact): - small dams between 3m and 10m height - construction of ponds for aquaculture	Except when already forbidden, any works or activities that might have a significant impact on protected aquatic ecosystems must submit an EIA, whatever their size or cost.	CONAGESE		
Burundi	Code on the Environment 2000		YNY		The introduction of any animal or plant species must be subjected to a full analysis... to provide assurance that the proliferation of the proposed species will not cause any harm to indigenous species nor to the natural ecosystem equilibrium.	INECN		
Cameroon	1996 Framework Law on Environmental Management 96/12	1996	YYY		EIA compulsory for a project likely to peturb biodiversity in aquatic environnement	CIE	General guidelines	No
Cape Verde	Act No. 86/IV/93 of 26 June 1993 defining environmental policy.	2006	YYN			CAN		
Central African Rep.	1989 Decree No 89-047 (Establishment of National Committee in charge of the Environment)		YYY					No

Country	Environment Law	EIA Regulations	CBD CPB ACCNNR	Explicit mention of aquaculture in EIA regulations	Explicit mention of EIA regarding introduction of alien species	EIA Oversight Institution	Guidelines published for EIA: general or aquaculture	Explicit SEA/SIA provision
Chad	1998 General principles on the protection of the environment		YYY		Conditions to be published by statute for introductions	HCNE		
Comoros	1994 Framework Law on the Enironment 94/018		YNY		The importation of living speciments of species not native to each of the Comores is banned	DGE		
Democratic Republic of Congo			YYY					
Congo	1991/1997 Law on the Protection of the Environment	1986	YYY			CGE/ANPE	General guidelines	No
Côte d'Ivoire	1996 Code on the Environment	1996	YNY		Any proposed activity must avoid any negative impact on biological diversity	BEI/MLCVE, ANDE		No
Djibouti	2000 Framework Law on the Environment	2001	YYY		EIA is required for the introduction of exotic species or new genetic material for extensive use	CNE		No
Egypt	M Environment Law 4/1994	1995	YYY	Aquaculture on the grey list: may need EIA		EEAA	General guidelines	No
Equatorial Guinea	1990		YYN					
Eritrea	1996 Environment Proclamation		YYN		Assessment required for introduction of alien species into an ecosystem			No
Ethiopia	1995	2002	YYY			NEPA	General guidelines	Yes
Gabon	1993 Law on the Protection and Improvement of the Environment	1979	YYY			DGE		
Gambia	1994 National Environment Management Act 94/13	1999	YYY	EIA required: for storage dams, barrages, weirs; fisheries especially large scale commercial projects;	EIA required: Introduction of alien species of fauna and flora into ecosystems;		General guidelines	No
Ghana	1994 Environment Protection Act 490/94	1999	YYY	EIA regulations: EIA mandatory for land-based aquaculture EIA for construction of dams / reservoirs Fisheries Act: EIA required to accompany any application for a licence for aquaculture; Fisheries Impact Assessments required for any activity impacting on a fishery (as well as EIA)		EPA	General guidelines	Yes
Guinea	1987 Code on the Environment	1990	YYY	EIA required: Aquaculture installations		Ministry		No
Guinea-Bissau	1993		YNN					
Kenya	Environmental Management and Coordination Act 1997	2003	YYY	Indirect: mandatory for dams, reservoirs, irrigation and large scale agriculture	EIA mandatory: introduction of alien species of fauna and flora into ecosystems	NEMA		Yes

Country	Environment Law	EIA Regulations	CBD CPB ACCNNR	Explicit mention of aquaculture in EIA regulations	Explicit mention of EIA regarding introduction of alien species	EIA Oversight Institution	Guidelines published for EIA: general or aquaculture	Explicit SEA/SIA provision
Lesotho	Environment Act 2001	2003	YYY	EIA required: dams, reservoirs, storage dams, weirs, canals …. etc.; projects which affect streams, floodplains, wetlands;	EIA required: introduction of alien species of fauna and flora into ecosystems; genetic modification of organisms and release of such organisms;	LEA		
Liberia	Environment Protection and Management Law	2002	YYY	mandatory for: 'artificial' fisheries (aquaculture for fish, algae, crustaceans, shrimps, lobster or crabs)	EIA mandatory for: Introduction of new species in waterbodies	EPA		No
Libya	1982 Law for protection of the environment		YYY					
Madagascar	1991 Environment Charter	1992/2004	YYY	EIA mandatory for industrial or intensive aquaculture PREE for semi-industrial and artisanal aquaculture Special measures for shrimp aquaculture	EIA mandatory for introduction of alien species; transfer of native species outside natural distribution; use/ introduction of any GMO; PREE for reintroduction of native species to area where previously present;	ONE	aquaculture guidelines	No
Malawi	1996 Environment Management Act (No. 23)	1998/2001	YYY	EIA mandatory: Construction of fish-farming or ornamental pond(s) where the capacity is greater than 100 cubic metres or where there is any direct discharge from a fishpond to a receiving waterbody. Reservoirs greater than 100ha	EIA mandatory: Any proposal to introduce fish species in an area where they do not presently exist.	DEA	General guidelines	No
Mali	1991 Protection of Environment and Life Framework 91-47	1999	YYY	EIA required: for dams and other permanent installations intended to retain or to stock water.				No
Mauritania		2004	YYY			Ministry		No
Mauritius	Environment Protection Act 2002	2006	YYY	EIA required: construction of dam and dyke; Preliminary environmental report required: Parcelling out of land above 5 hectares for agricultural purposes involving infrastructural work	EIA required: development, production, release, use, marketing and application of genetically modified organisms; rearing of introduced species…;	Ministry	General guidelines	Yes
Morocco	2003	2003	YYN	EIA required: aquaculture and fish culture projects; dams and reservoirs	"the laws determine the conditions for the introduction, from whatever origin, of any animal or plant species which could harm protected species or their natural environment"	DE/CNEIE		No
Mozambique	Framework Environmental Act (No. 20 of 1997)	1998	YYY	EIA required: fish farming projects, with an area equal to or greater than 5 hectares		MICOA	General guidelines	
Namibia	Environmental Management Bill (2007)	policy 1994	YYN	EIA required: aquaculture and mariculture	EIA required: genetic modification of organisms and releases of such organisms	EC/DEA	aquaculture guidelines	Yes
Niger	1998	2000	YYY	Indirect: EIA required for dams and reservoirs >5 ha;		BEEEI		Yes

Country	Environment Law	EIA Regulations	CBD CPB ACCNNR	Explicit mention of aquaculture in EIA regulations	Explicit mention of EIA regarding introduction of alien species	EIA Oversight Institution	Guidelines published for EIA: general or aquaculture	Explicit SEA/SIA provision
Nigeria	58/1988; 59/1992	1992	YYY	EIA required: Land based aquaculture projects accompanied by clearing of mangrove swamp forests covering an area of 50 hectares or more; dams and man-made lakes and artificial enlargement of lakes > 200 ha		FEPA	General guidelines	No
Rwanda	Organic Law No 04/2005 Measures to protect, safeguard and promote the Environment		YYY			BEIE		Yes
São Tomé and Principe		1999	YNN	indirect: EIA for projects or programmes of agriculture or elevage which singly or cumulatively exceed 20 ha				Yes
Senegal	1983 Code on the Environment	1983	YYY	Indirect: preliminary review for irrigation and small and medium agri-business.	EIA compulsory for projects likely to have negative consequences on biodiversity	Ministry	General guidelines	Yes
Seychelles	1994 Environment Protection Act	1996	YYY	EIA required: fish farming works and extension, aquaculture; dams and reservoirs;	Avoid the introduction of foreign species, except when assured that there is no risk that these might escape into the natural environment		aquaculture guidelines	No
Sierra Leone	2000 Environmental Protection Act		YNY	EIA required: substantial changes in farming and fisheries practices eg introduction of new crops...; dams, drainage or irrigation projects…;				No
Somalia			NNY					
South Africa	1998 National Environmental Management Act 107/98	2006	YYN	Basic envionmental assessment required for: aquaculture production, including mariculture and algae farms, with a product throughput of 10 000 kilograms or more per year; The release of genetically modified organisms into the environment; Full EIA required for dams over 10 ha	Assessment of risks and potential impacts on biodiversity must be carried out for introduction of alien species	NEMA	aquaculture guidelines	Yes
Sudan	Environmental Protection Act of 2001.	N	YYY	N				No
Swaziland	2002 Environmental Management Act	2000	YYY	N		SWA	General guidelines	Yes
United Republic of Tanzania	2004 Environmental Management Act	2004	YYY	EIA mandatory: 'artificial' fisheries such as aquaculture for fish, algae, crustaceans shrimps, lobster or crabs; large scale fish farming including prawn farming; EIA may or may not be required for: small-scale fish culture; small animal husbandry and urban livestock keeping; sea weed farming	EIA required: introduction of new species in waterbodies; introduction of genetically modified organisms	NEMC	General guidelines	Yes

Country	Environment Law	EIA Regulations	CBD CPB ACCNNR	Explicit mention of aquaculture in EIA regulations	Explicit mention of EIA regarding introduction of alien species	EIA Oversight Institution	Guidelines published for EIA: general or aquaculture	Explicit SEA/SIA provision
Togo	1988 Code on the Environment 88-14	2006	YYY	Require EIA: dams and reservoirs(> 5ha < 10 ha: Simplified EIA, > 10 ha: In-depth EIA); Aquaculture/Fish culture (< 300 ha: Simplified EIA, > 300 ha In-depth EIA). Extraction of water from rivers, underground, lakes, lagoons and the sea… for aquaculture, requires authorisation from the Ministry of Environment	Require EIA: Introduction of alien species (in-depth EIA); Introduction of genetically modified organisms (in-depth EIA); transfer of existing species out of current distribution range (simplified EIA).	Ministry		Yes
Tunisia	1988 Law No 88-91 Establishment of a National Agency for the Environment	1988/ 1991	YYY	EIA is mandatory for mollusc farming (category A); aquaculture projects (category B).		ANPE	General guidelines	No
Uganda	1995 National Environment Act	1998	YYY	EIA required: storage dams, barrages and weirs	EIA required: "introduction of alien species of fauna and flora into ecosystems";	NEMA	General guidelines	No
Zambia	Environmental Protection and Pollution Control Act, No. 13 1990	1997	YYY	EIA required: dams and barrages > 25ha; fish farms (production > 100t per year);	EIA required: Introduction of alien species of flora and fauna to local ecosystems.	ECZ	General guidelines	No
Zanzibar (United Republic of Tanzania)	Environmental Management for Sustainable Development Act, 1996	2002				Dept Env		No
Zimbabwe	2002/05 Environmental Management Act	1997 g'lines	YYN	EIA required: dams and man-made lakes; irrigation schemes	prohibit or control the importation of and introduction into the wild of exotic animal and plant species;		General guidelines	No

Sources: Algeria, 1990, 2001, 2003; Benin, 1999, 2001; Botswana, 2005; Burkina Faso, 1997, 2001; Burundi, 2000; Cameroon, 1996; Cape Verde, 2006; Chad, 1998; Comoros, 1994; Congo, 1986; Côte d'Ivoire, 1996; Djibouti, 2001; Egypt, 1994, 1995, 2004; Ethiopia, 2002; Gabon, 1993; Gambia, 1994; Ghana, 1999, 2002; Guinea, 1989; Kenya, 2003; Lesotho, 2001; Liberia, 2002; Madagascar, 2004; Malawi, 1996; Mali, 1999; Mauritania, 2004; Mauritius, 2002; Morocco, 2003a, b; Mozambique, 1998; Namibia, 1994, 2002; Niger, 2000; Nigeria, 1988, 1992, 2007; Rwanda, 2005; Sao Tome and Principe, 1999; Senegal, 2001; Seychelles, 1994, 2003; Sierra Leone, 2000; South Africa, 1998, 2004, 2006a, b; Swaziland, 2000; Togo, 1988, 2006; Tunisia, 2005; Uganda, 1998.

or civil society being fully aware of the extent of the changes. Although institutions responsible for the environment are now given a higher profile than previously, there is a perception in some countries that they are still relatively lightweight when compared to some of the traditionally heavyweight sectoral ministries that manage policy priorities for economic and production growth. Unless it has been developed with close inter-ministerial collaboration, this can leave environmental law in some isolation making application more difficult. In more and more cases sectoral ministries are taking environmental concerns on board and harmonising their own legislation. At the same time environment ministries are receiving a higher profile and these factors, combined with growing awareness of government personnel, are making it increasingly likely that EIA will be required and applied.

EIA OBJECTIVES

Although EIA is intended as a project specific study in most African regulations, the extent of the assessment expected can differ according to the overall objectives of the process as defined by different national policies.

At one level it can be implemented as a quite limited licensing procedure for a new installation, ensuring that it will meet minimum standards and essentially limiting the study to impacts "at the farm gate", in an exercise that can be described as control of pollution and local habitat degradation.

With commitment from both farmers and environmental authorities EA can become a much more substantial tool in support of "best practice" for sustainable aquaculture. This adopts wider boundaries than a project-level EIA for the environmental assessment incorporating concern for social and economic spheres as well as upstream and downstream interactions with the natural environment.

EIA, ESIA, SIA, SEA, ESMP, ESD, EAA[5], etc.

There are many related and sometimes confusing acronyms. As the focus of environmental assessment has evolved over the past two decades a number of approaches have been put forward to assist the decision-making process for sustainable development, and the acronyms cited here represent just a few of these variations. They all recognize the interlinked nature of our existence and the way that any new activity can produce reverberating effects through our environment, sometimes in unexpected ways. Put simply, they are an indication of how the boundaries of our definition of the environment have changed in relation to assessment, recognising that some of the key impacts of developments are found away from the project site – either elsewhere in the ecosystem, outside in the community or linked to parallel developments in the supply chain.

Africa, which in most cases has yet to commit to extensive use of these procedures, is still able to reflect on how best to position itself in relation to the environmental debate. The African Union has set some markers for this and has tended to recognize that the wider boundaries of environment are important. The Abuja declaration (NEPAD, 2005) identifies impacts on communities from aquaculture as needing to be managed and the African Convention on the Conservation of Nature and Natural Resources (ACCNNR)(African Union, 2003) recognizes that impacts are on the whole of the ecosystem irrespective of national boundaries.

How this will affect aquaculture, which is still a sector on the brink of development,

[5] **EIA**: Environmental Impact Assessment
ESIA: Environmental and Social Impact Assessment
SIA: Social Impact Assessment
SEA: Strategic Environmental Assessment
EAA: Ecosystem Approach to Aquaculture
ESMP: Environmental and Social Management Plan
ESD: Environmentally Sustainable Development

is now being decided in the different countries as they start to acquire experience in environment assessment for the sector. It is still partly a case of deciding which impacts are acceptable to local society and political opinion, and which mitigation measures are considered necessary or affordable. The debate is already far better informed than a few years ago, and with reasonable reliance on environmental awareness and assessment, most negative impacts from aquaculture can be avoided or greatly reduced.

LEVEL OF USE OF EIA IN AFRICA FOR AQUACULTURE PROJECTS

The progressive introduction of EIA regulations in Africa over the past 15 years has not yet resulted in a large number of EIAs being carried out in aquaculture. In part this is to do with the low level of growth of aquaculture at present and this can be expected to change. However, as will be seen from the case studies below, there are already precedents in aquaculture in a few African countries where EIA is becoming an active part of the decision-making processes.

Apart from the generally low level of aquaculture development there are some other reasons why EIA is not more widely used in aquaculture:

- aquaculture is not often perceived as "high risk" so is not a priority to environmental authorities; there have been few, if any, obvious negative impacts from aquaculture in many countries;
- the small-scale of most aquaculture in Africa;
- a reluctance to appear to put obstacles in the way of local investors when well established local policies are tilted towards increasing food production and economic expansion;
- the laws are new and untested and there are insufficient trained staff in environmental and fisheries departments;
- aquaculture is a low priority for under-resourced environmental institutions.

Many of the EIAs to be carried out for aquaculture projects in Africa have been for big commercial farms, that have often received investment from private sources overseas or support from international agencies or banks. The expectation of these partners is such that EIA is part of the project installation, even where there may not have been comprehensive national legislation. Most of these agencies have introduced a requirement for EA (World Bank, 1999a), usually using the instrument of EIA, and have established their own criteria and guidelines for this. In the absence of national legislation, guidelines and local expertise, new projects have carried out the EIAs principally with their own resources using guidelines and methodologies of the institutions such as the World Bank and the United Nations Environment Programme (UNEP). A major factor in the bias towards EIA being used for internationally financed projects is their larger scale, as opposed to most domestic initiatives which are often of a much smaller size.

EIA within the context of international investment and development assistance

Three of the major institutions financing projects, including aquaculture, in Africa are the World Bank, the African Development Bank (AfDB) and the European Union (EU). They now all have policies and detailed procedures which ensure that environmental assessment is carried out for aquaculture projects which they finance. Sometimes this will require a full EIA study of the project, but if the anticipated environmental impact is not significant then a reduced assessment may be sufficient. These institutions screen their projects to determine the nature of the assessment that is appropriate (see Box 3). In cases where the national regulations operate and thresholds are higher, a project will have to satisfy those thresholds if it is to receive support; in cases where the national thresholds are lower or there are no equivalent regulations, the institutional EA requirements would be applied.

BOX 3

Aquaculture thresholds for EIA determined by external institutions

A. World Bank (World Bank, 1993)
A.1. "*Category A projects that are likely to have adverse impacts: a full EIA is needed in accordance with the specific requirements of the Bank's EA policy … including in areas such as public disclosure, public consultation…*" These include:
– aquaculture and mariculture (large-scale);
– dams and reservoirs;
– irrigation, drainage and flood control (large-scale).
Also *likely to induce significant impacts upon biodiversity* and so classified as Category A (World Bank, 1997):
– fisheries/aquaculture projects involving conversion of important natural migration, breeding or nursery sites, over-fishing, introduction of exotic species.
A.2. "*Category B projects that may have environmental impacts for which more limited EA is appropriate*". The following projects and components may have environmental impacts for which more limited (Category B) EA is appropriate:
– agro-industries (small-scale);
– irrigation and drainage (small-scale);
– protected areas and biodiversity conservation;
– watershed projects (management or rehabilitation).
B. African Development Bank (AfDB, 2001)
B.1. "*Category 1 projects are those that are likely to have the most severe environmental and social impacts and require a full ESIA.*" These include:
– large-scale aquaculture/mariculture;
– river basin development;
– large scale dams and reservoirs.
B.2. "*Category 2 projects are likely to have detrimental and site-specific environmental and social impacts that can be minimized by the application of mitigation measures included in an ESMP.*"
– small-scale aquaculture/mariculture;
– small-scale irrigation and drainage;
– watershed development (management or rehabilitation);
– intensive animal production;
– dams and small reservoirs.
B.3. "*Category 2 projects would be subject to Category 1 EA if they i) affect environmentally sensitive areas or ii) impact on socially sensitive issues.*" These include e.g. mangrove swamps, small islands, tropical rainforests, wetlands of national importance.
C. European Union (CEC, 1993)
C.1. "*Screening List C: Projects requiring full EIA*". Includes:
– industrial fisheries.
C.2. "*Screening List B: Projects requiring further environmental analysis.*" Includes
– intensive aquaculture (large-scale);
– extensive aquaculture (exceeding 50ha, or exceeding 10ha if affecting mangroves);
– artisanal fisheries (large-scale);
– introduction of new species;
– introduction of new harvesting technology.

As far as aquaculture is concerned, although the general principles behind the use of EIA are very similar, the screening thresholds do vary slightly between these investing institutions. None of the thresholds are intended as inflexible, and there is always the proviso that any project which appears likely to have significant impact should undergo

EA. The World Bank distinguish between "large-scale" and "small-scale" aquaculture and mariculture, while suggesting that the final category designation should always be a matter of "professional judgement". The AfDB has similar distinctions between large and small-scale, but is more prescriptive and introduces detailed definitions of special conditions whereby Category 2 project types should be included as Category 1 for EIA. The EU takes a slightly different approach and includes most aquaculture as "requiring further environmental analysis", which may or may not involve EIA. The EU guidelines regret that development assistance agency EIA procedures designed for large and complex infrastructure projects are often applied to the assessment of smaller, more routine, projects.

POLITICS AND EIA

Although EIA is supposedly a rational approach to deciding the merits of a project on the basis of predictions of its impact on the environment, there are less tangible influences on how the process is actually used. One of these is politics, whether national or local, and there is usually a political dimension to an EIA. Environmental concerns have been moving closer to the centre of political debate in Africa, as it has globally. This is particularly marked in some countries such as Uganda, South Africa or Ghana where both politicians and media are now quick to focus on the environmental aspects of an issue. This political awareness is important for the effective use of EIA, as it provides the will to follow through on the national legislation as well as encouraging the public's participation in the process. On the other hand, a lack of political will – or worse, deliberate smothering of environmental debate – can make EIA ineffective.

In cases where "Environment" is seen as a distinct and separate sector of government, there is a risk that its policies can be, or at least perceived to be, in competition with other national policies which may have top level support – such as economic growth targets or creating a favourable climate for foreign investment. When this happens, the environmental regulations can be perceived by senior decision makers in government as obstructing their development plans. Authorities in the United Republic of Tanzania, for instance, have struggled with this issue over certain aquaculture project proposals (see Box 8).

"Mainstreaming" of environmental concerns into the wider political sphere, at both national and local levels, is the route that would make EIA less controversial (by the setting of common goals by partners inside and outside the sector) and less costly (by encouraging appropriate choices early in the project cycle).

CAPACITY AND HUMAN RESOURCES

Although EIA is usually defined as a project level activity, it in fact requires the involvement of a variety of "stakeholders" at each stage of the process, and resources must be made available to train and inform all of them before they can be effective managers or participants in what is quite a complex methodology.

First of all the national authority responsible for oversight of the environmental regulations needs the expertise to elaborate policies for environmental assessment, prepare comprehensive guidelines, conduct project screening, EIA scoping, EIS review and follow-up of monitoring. In some countries – such as Ghana – there is already a considerable workload of over a thousand EIA applications each year, although very few concern aquaculture. Without strong oversight capacity, it is very difficult to ensure proper compliance with the regulations.

Elsewhere in the public sector, the aquaculture agency/department needs to acquire similar expertise in order to fulfil their role in promoting and organizing the sector within the requirements of the legal framework. Strategies and policies will need to be adjusted to the evolving concerns about the possible effects of activities like aquaculture on the environment. Managers of the important resources sectors, such as water, also need to be included.

There is also a need to build capacity in the private sector so that competent consultants are available to conduct the EIA studies for project investors (CLEAA, 2007b). Producers associations do get involved in promoting controls on professional capacity, setting minimum standards or certifying procedures.

Apart from these core services that are required, there is also much to be done in less specialized spheres of civil society, especially in Africa where there is little experience of public participation in environmental decision-making. Committing efforts towards informing and sensitizing some of the following groups about the environmental issues at stake will greatly improve the quality of EIA output:

- Non-governmental organizations (NGOs) involved in e.g. development, environment, human rights;
- media journalists;
- teachers, students, parliamentarians, rural communities, traditional leaders;
- practicing fish farmers/aquaculturists themselves;
- lawyers/judges and the court system for resolving conflict.

Country case studies

EGYPT

Brief background to aquaculture activities

Aquaculture has a long history in Egypt but it is over the past 10–15 years that there has been a rapid increase in production (FAO, 2004-2008. NASO Egypt). Total production now exceeds 500 000 tonnes of fish, making Egypt the major producer in Africa by some distance.

Traditional methods have been extensive, based on growing out wild caught fry of tilapia and mullet in shallow ponds, usually without significant inputs. Carp have also been increasingly cultured since the 1970s; grass carp notably being well established for biological weed control in irrigation and drainage canals.

The rapid growth of recent years has been achieved by the increase in number of aquaculture farms, but also significantly by the intensification of farming techniques. Improved pond construction as well as new structures such as cages, tanks and raceways have been introduced. Hatchery produced fry, feeding, fertilisation of ponds and aeration are now common. Tilapia *(O. niloticus)* have become the dominant species, but other species such as seabream, seabass and shrimp have been introduced into the sector.

Background for the legal framework

The legal framework for aquaculture in Egypt is relatively well established (FAO, 2004-2008. NALO Egypt) and has developed out of necessity over several decades. Egypt has uniquely severe constraints on its water and cultivatable land resources and as a result, a body of legislation has been created to govern essential resource use that applies also to aquaculture and fisheries. A substantial number of the regulations are directed at minimising degradation of the aquatic environment centred on the Nile River, although their formulation predates the current environmental approach, and does not use current vocabulary such as "environmental assessment".

Fresh water, for which virtually the only source for the country is the inflow of the river Nile, has long been the object of control by the authorities. There is no "surplus" and water has to be shared in an orderly manner; agricultural crop production and urban supply and sanitation are the main priorities. Freshwater aquaculture has had a small presence upstream of the Nile delta but water would not normally be made available there for this use. The situation in parts of the Nile delta is somewhat different; here the land and water conditions are less favourable to traditional agriculture, and aquaculture has long found a niche. Some of this uses freshwater, but there have been important opportunities for aquaculture in brackish water, partly due to salinization of soils and encroachment of seawater. In fact, aquaculture has been encouraged in some areas as being an activity that can improve the quality of the land being used and make it more suitable for agriculture.

In these conditions there are extensive aquaculture practices that have proven successful and until recently the most common methods used shallow ponds to produce mullets, tilapias and carp. However, even in the delta the resource pressures have increased and this has favoured the introduction of new more intensive aquaculture methods.

Good returns on investment in the current market for fish have encouraged new farms, and production has recently soared as the more intensive methods are developed using both traditional species (tilapias, mullets, carps) as well as new species (seabass, seabream and shrimp). At the same time new approaches to agriculture are being developed and land reclamation projects are being implemented; the pressure on water and land continues to increase. Water is in short supply and is re-used more than once, which raises questions of water quality – in terms of the quality of water being made available for an activity/use and at the same time the quality of water in the drainage or outflow from that activity/use. Together, these conditions explain the comprehensive and detailed nature of the Egyptian legislation governing pollution control, resource sharing, water quality and licensing of activities, all of which are concerns to be addressed in any EIA for aquaculture.

Legal framework influencing environmental issues and aquaculture

The overall legal framework within which the aquaculture sector works is quite complex as can be seen from Table 3. All these laws grapple with environmental concerns over the quality and quantity of resources available to different users (Egypt EEAA, 2001; Egypt, 1982; FAO, 2004-2008. NALO Egypt).

The Ministry of Water Resources and Irrigation (MWRI) has the primary legal responsibility for the planning and management of all water resources in Egypt. It is responsible for providing water of suitable quality to all users. To accomplish this goal, the ministry has to ensure that appropriate measures are undertaken to protect both the quantity and the quality of Egypt's water resources. With increasing trends of pollution, MWRI is intensifying its attention towards pollution control and water quality management.

The Ministry of Health and Population (MoHP) has also been given a central role in water quality management, especially in setting standards for the quality of the following:

- potable water sources (River Nile, canals and groundwater wells);
- drain water that can be mixed with other water for drinking water;
- industrial and sewage treatment plant discharges.

TABLE 3
Statutes governing aquaculture in Egypt

Environmental law	Date	Objectives	Decrees Regulations	Implementing Agency
Law 12 (and its supplementary Law 213/1994)	1984	Main legislation for irrigation and drainage	Has recently been revised and submitted to Parliament	MWRI
Law No. 4 on Environment	1994	Establishment of EEAA and Environmental Protection Fund; requirement of EIA; regulation of air pollution, hazardous waste management and marine pollution	Decree No. 338 of 1995 (Executive Regulation including Prime Ministers Decree No. 1741 of 2005)	MoEA; EEAA
Law No. 102 on Natural Protectorates	1983	Designation and management of natural protectorates	Decrees designating sites	MoEA; EEAA
Law No. 124 on Fisheries	1983	Management and protection of fisheries and marine animals		MALR
Law No. 48 on Protection of Nile and its Waterways	1982	Control of pollution of surface waters	Decree No. 8 of 1983 (standards for wastewater discharges to surface waters)	MWRI
Law No. 137 on Labor	1981	Control of work place safety and environment		Ministry of Manpower and Immigration
Law 92/1962 Waste water discharge	1982	Control of wastewater discharge into public sewers	Decree 9/1989	MHUNC

The Egyptian Environmental Affairs Agency's (EEAA) functions, as established by the Environmental Law 4/1994, include:

- conducting studies; formulating the national plan for environmental protection;
- preparing legislation, decrees and regulations as needed to protect the environment;
- setting requirements for EIAs of projects;
- monitoring compliance with standards and norms;
- coordinating enforcement actions;
- managing natural protectorates;
- promoting environmental education.

The EEAA has significant authority over industry under this law, including the authority to require industries to keep records of the environmental impact of their activities and to collect and analyse samples to ensure that standards are being met.

The fundamental issues of environmental impact are also governed by earlier laws for resource sharing and pollution control that are still applied, but which date from before the current environmental framework being put in place, and use a rather different vocabulary.

The Law 93/1962 regulates discharge into the public sewers and in this respect Decree 9/1989 sets out specific limits to many potential pollutants. Law No. 124 / 1981 prohibits the use of fresh water in aquaculture. Law 48 /1982 enforced by the Ministry of Water Resources and Irrigation regulates discharge into branches or canals of the Nile, to the main stream of the Nile, and elsewhere. The concerns covered by these two laws would necessarily be included in an EIA, and the relevant measurements could be a significant part of the data included in the environmental register required by Law 4/1994.

In addition, Law 124/1983 covering fishing, aquatic life and aquaculture, has several articles specifically on aquaculture and its relationship with the nation's resources and environment (Egypt, 1983). This law requires licensing of aquaculture farms by General Authority for Fisheries Resources Development (GAFRD). Conditions that should be satisfied for obtaining a license (valid for up to five years) include:

- land used should be in areas allocated for fish farming and should normally be otherwise unsuitable for agriculture e.g. uncultivated un-reclaimable (fallow) lands, drain outfalls and certain Northern Lakes;
- license must indicate the quantity of water permitted for water use, its source, inlet size and the method of drainage;
- authorization for water use obtained from the Ministry of Water Resources and Irrigation, in conformity with Law 48/1982;
- a satisfactory EIA and the consequent approval of EEAA.

Egypt is also a party to the Convention on Biological Diversity (CBD) and to the Biosafety Protocol, which might influence choices relating to species introductions and use of modified strains of fish.

Aquaculture and requirements for EIA

The Environment Law No. 4/1994 (Egypt, 1994) is the principal legislation enacted to govern interactions with the environment in Egypt. It is this law that creates the obligation to undertake EIA under certain conditions. This is the case of aquaculture which is designated as an activity "which may have a noticeable impact on the environment" and requires an EIA to be submitted before approval can be given, and before work can commence. This law also requires that any establishment of this nature prepares an environmental register which must be regularly updated to record the impact of the establishment's activities on the environment. The executive regulations determine the standard form of the required register, the time table required to keep it up to date and the data to be entered (Sadek, 2007).

Screening and establishing liability to EIA

Sectoral ministries and governorates can be the competent administrative authorities for EIA, as they possess the executive powers in relation to development authorization. Additionally, they are required by Law 4 and its executive regulations to conduct the screening of projects (METAP, 2000).

The central EIA department of the EEAA is responsible for supervising the screening process, managing the review of EIA reports (either by undertaking reviews itself or by assigning independent bodies or individuals to do so), taking decisions on the acceptability of EIA reports and giving an opinion on the development and proposals for mitigation measures. EEAA also has the responsibility for issuing EIA guidelines.

The recommended process for the EIA is generally well defined in guidelines issued by the EEAA, and follows a sequence of steps and required documents:

Project presentation >> screening >> scoping >> consultation >> baseline data collection >> impact prediction and evaluation >> monitoring plan >> environmental impact statement.

Screening criteria have been published and activities separated into three categories according to the severity of possible environmental impacts as follows:

1. White list projects for establishments/projects with minor environmental impact, which do not require an EIA;
2. Grey list projects for establishments/projects which may result in substantial environmental impact and which may require a scoped EIA;
3. Black list projects for establishments/projects which require complete EIA due to their potential impacts.

Aquaculture, in principle, is included in the Grey List, although it could be Black List if proposed in a designated environmentally sensitive area. In practice this means that an EIA would normally be expected unless the project can demonstrate early in the screening process that it would have only minor environmental impact.

Once an EIA is declared necessary, the next stage is scoping to decide which environment impacts have to be covered and in what detail. Consultation with the public is expected to be initiated at this stage and would continue until the potential impacts have been identified and mitigation measures are considered. Once the scoping has been completed, the details of the EIA can be planned. Baseline data, using both existing and new original data, is now collected.

A significant part of the data to be studied in the Egyptian situation involves water, both quantity and quality; the impact concerns are not necessarily in relation to the "natural" environment, but often in relation to other economic users upstream and downstream. Issues of impact on the natural environment are more important in some of the sensitive wetland habitats of the delta previously uncultivated. Occupation of space is important, whether in potentially cultivatable land or water surface of the shallow Nile delta lakes, as it is (or will become) an issue of competition for space. Social impacts are not negligible as aquaculture will often be replacing alternative land uses and also affecting the fishing industry (e.g. impacts on the areas available to fish, on natural fish populations and their movements).

Practical issues for applying EIA to aquaculture

Mechanisms for the control of pollution, in particular of the aquatic environment, have been in place in Egypt for a long time before the process of EIA was introduced. Law 4/1994 takes the "bigger picture" on the environment, although the earlier laws and the divided responsibilities of the multiple ministries and agencies remain in place. In theory the introduction of EIA provides a mechanism to bring together these various – sometimes "competing" – institutions so that the diverse legislation relating to environmental resources is applied in a coordinated manner towards the objective of sustainable resource use.

These multiple laws could present some difficulty to aquaculture farmers. There is a risk that the EIA becomes just one more in a series of bureaucratic hurdles for the farmer/entrepreneur each of which has to be resolved independently with each institution involved: EEAA, the Ministry of Agriculture and Land Reclamation (MOLAR), Ministry of Water Resources and Irrigation, GAFRD and other local Competent Administrative Authorities.

In practice, EIA is rarely conducted for aquaculture activities *per se*. The vast majority of these are activities operating in fresh/brackish-water environments and they continue to be regulated by the "older" legal frameworks of the various sectoral ministries, coordinated to some degree by GAFRD. EIA is not required before a farmer begins aquaculture production. The only situation, which may become more frequent if open sea aquaculture develops, where the EIA required is in the marine environment (coastline, open marine waters) where the established rules for inland waters do not apply and the Environment Law administered by the EEAA holds sway.

EIA and the environmental logic behind the process are unlikely to succeed as priority of environmental ministries on their own, without wider understanding and support from the rest of the administration, the business and farming sectors and from the community as whole.

The slow uptake of the use of full EIA studies is not unique to freshwater aquaculture, and has been noted in a wider context (Genena, 1996). The reasons suggested are perhaps not surprising and are reflected in similar challenges in other African countries:

- high costs of environmental monitoring and testing;
- lack of skilled and trained human resources;
- unclear roles, responsibilities and legal requirements;
- overlap with existing inflexible permitting arrangements.

Cage based aquaculture provides an example of how environmental impact concerns can influence development. Cages have been used for freshwater aquaculture since at least 1985, mostly for tilapia – although more recently silver carp has been used and in 2003 production reached 32 060 tonnes from 3 753 cages. However, since that date the practice of cage farming in the channel of the two major branches of the Nile has encountered stiff opposition from legislators (based on the general water use regulations and navigation concerns) and environmentalists. There are currently efforts being made to reverse this decision and EIA has been proposed as part of the process of finding a solution acceptable to all parties.

Limited land and water resources (physical and self-imposed by existing legislations and policies) and the relatively low levels of production, indicate that the way forward for Egyptian fish farmers will probably be to intensify their production and take full advantage of new technologies and management procedures. However, with intensification come higher environmental risks from adverse effects on the environment, as well as higher production risks from higher levels of inputs, the need for water quality and fish health management. EIA may come to be seen by the whole sector as a key tool in managing this transition in a way that is sustainable and protects the resources from the ever increasing pressures of its multiple competing users.

MADAGASCAR

Brief background

Aquaculture has a relatively long history, and the first recorded efforts of fish farming date back 70 years. Freshwater fish farming has been established the longest, and historically this has primarily been focussed on rice/fish culture, raising fish in the rice paddies that are so widespread across the country (FAO, 2006-2008. NASO Madagascar). The methods used are mostly extensive or semi-intensive, with carp as the main species. In the past 20 years more intensive methods have been applied to carp fry production, although the hatcheries are all also at a small-scale. In environmental terms, the impact of these activities is quite minimal and is absorbed into the general agricultural landscape.

More recently Madagascar has developed an aquaculture industry of global reputation for the indigenous shrimp *Penaeus monodon*. Since the inception of this activity in Madagascar the shrimp producers have made a virtue of striving for an environmentally sustainable approach, to avoid some of the major pitfalls that have overtaken the development of shrimp culture elsewhere in the world. The success of this approach has significantly influenced the environmental legislation and its application in Malagasy aquaculture. The country is actively seeking to develop the commercial exploitation of other new species, both in fresh and marine/brackish water environments, which if practiced at a large scale, as projected, can also be expected to raise issues of environmental impact; these include e.g. seaweeds, sea cucumbers and eels.

The uniqueness of the indigenous biodiversity and the natural ecosystems that exist in Madagascar is well known, and there is a long history of national and international interest in protecting these exceptional environmental assets. This is one reason why Madagascar has a notably comprehensive and well developed environmental legal framework which has evolved over the past two decades. This framework addresses concerns not only for conservation of the island's unique flora and fauna, but also for all major sources of impact such as mining, causes of soil erosion and the wider issues arising from urbanisation and economic development. Aquaculture and fisheries are explicitly included in environmental legislation.

Of note to this general background, however, is the special situation concerning freshwater aquatic biodiversity. The freshwater ichthyofauna of Madagascar is unusually influenced by alien species. There are 29 introduced species, some of which were introduced specifically for aquaculture. These include such genera as Ophiocephalus sp., Oreochromis sp., Tilapia sp, which have come to dominate many of the aquatic environments and fisheries. Exactly how they have affected the biodiversity of endemic aquatic fauna and flora is more or less unknown, because the latter are also under pressure from habitat loss (Shumway, 1999), but we do know that there are 50 fish species (all aquatic environments) considered to be threatened (extract from FishBase, 2007). This would raise challenging questions when considering the future introduction of species for aquaculture as part of an EIA, and conflicting points of view should be expected when considering the potential impact. Does the parlous state of some endemic species make new introductions unthinkable? Should the established species of alien origin, which includes several of economic and social importance, be protected from adverse potential impacts as part of the status quo of the country's biodiversity, or could the freshwater aquatic ichthyofauna be considered so "cosmopolitan" already that a further introduction is not of great consequence to aquatic biodiversity and can be judged uniquely on economic criteria? Against this background the current legislation requires that EIA be applied to both the introduction of alien species, as well as the movement of native species outside their range.

Legal framework for environmental assessment

The present framework of environmental law dates from 1984 when the Malagasy Strategy for Conservation and Sustainable Development was adopted (décret n° 84-445 du 14 décembre 1984). In 1990 The Malagasy Environmental Charter was adopted by the Law n° 90-033 (Madagascar, 1990). This lays out a comprehensive approach to environmental policy, including the need to legislate for the mitigation

TABLE 4
Malagasy legislation concerning aquaculture and the environment

Sector	Statute name	Reference	Content	National Institution
General Environment	Malagasy Environmental Charter	Law No 90-033 of 21 December 1990	Lays out overall national environmental policy	
	Creates the National Environment Office (O.N.E.)	Decree No 95-607, 1995 on the establishment and organization of the National Environment Office (O.N.E.).	Creates the National Environment Office (O.N.E.)	Autonomous under the technical control of MINENEF
	Law to ensure Compatibility Between Investment and the Environment (“MECIE”)	Decree MECIE No 2004-167 of 03 February 2004 modifying certain provisions of Decree 99.954	Procedures for obtaining environmental permits; EIA regulation	MINENEF, O.N.E., and sectoral Ministries e.g - MAEP
Marine Aquaculture	Fisheries and Aquaculture Regulations	Ordennance 93.022 of 04 May 1993	Overall sector legislation	MAEP
	Law for the Development of Sustainable Shrimp Culture	Law No 2001.020 of 12 December 2001	Procedure authorization of aquaculture farm, environmental regulation, disease control	MAEP
Freshwater Aquaculture	Fish Hatchery Regulations	Arrêté 5321-2002/ MAEL/SEPRH of 17 October 2002	Procedures for obtaining authorization	Fisheries Department
	Creation of Technical Committee for the promotion of monosex tilapia production	Interministerial Order No 22914/2004 of 29 November 2004	Procedures, including use of hormones	DPRH, FOFIFA, MINSAN, DSAPS, MINENV, ARDA, APAM, MPE

of environmental impacts of development activities. The consequent legislation introducing procedures for obtaining environmental authorization, including the implementation of environmental impact assessments, was introduced in decrees in 1999 and 2004 (see Table 4).

The details of the EIA regulations are laid out in the Law 2004/167. The title of this statute “Law to ensure compatibility between investment and the environment” (“MECIE”) is unusual and worthy of note – most are simply called “EIA regulations” or something similar. This one, however, makes an interesting reference to *compatibility* between *(development) investment* and the *environment* and thus encapsulates the notion that it is a balance that most African countries will strive to achieve between economic development and the inevitable impacts this will have on parts of the environment.

Under the MECIE (Madagascar, 2004) regulations aquaculture could fall under more than one article when considering whether a project is required to carry out an EIA before commencing:

Under article 5 and its annexes: Any animal production project which falls into the categories “semi-industrial or small-scale enterprise” (*“Tout projet d’élevage de type semi-industriel et artisanal”*) would require the approval of a PREE (Environmental Commitment/Responsibility Plan). This stops short of a full EIA and applies to smaller scale activities.

Under article 4, and its annexes, the following are required to complete a full EIA before obtaining an Environmental Authorization from the environmental authorities:

- any industrial or intensive animal production project (*“Tout projet d’élevage de type industriel ou intensif”*);
- any water extraction over 30 m^3/h - (*“Tout prélèvement d’eau (eau de surface ou souterraine) de plus de 30 m^3/h”*);

- any introduction of a new species, or genetically modified organism, into the country (*"Toute introduction de nouvelles espèces, animales ou végétales, ou d'organismes génétiquement modifiés (OGM) sur le territoire national"*);
- any introduction of a species present in Madagascar but not already present in the project zone *("Toute introduction d'espèces présentes à Madagascar mais non préalablement présentes dans la zone d'introduction"*);
- any project to be created in a sensitive area (*"Tous aménagements, ouvrages et travaux pouvant affecter les zones sensibles"*).

Practice

In practice most aquaculture operations must consider whether or not they are liable to prepare a PREE or undertake an EIA. Article 5 of the EIA regulations requires all "semi-industrial and artisanal" aquaculture projects to provide a PREE (Environmental Commitment Programme), while "industrial or intensive" projects should normally undertake a full EIA as defined by article 5/annex 1 (Madagascar, 2004).

The key stage for this will be the screening process. There is some discretion as to which category an individual project will fall into, not least because in most cases the terms used in the law (e.g. intensive, semi-intensive) are not precisely defined. Some situations requiring EIA are better defined such as projects in sensitive habitats or involving water extraction of more than 30 m^3/h.

In the current situation in the freshwater environment, the large numbers of farmers involved with rice/fish culture are not expected, now or in the near future, to be included in either of these approaches. A rural fry production hatchery might be required to prepare a PREE, depending on its size and the methods used. To date this hasn't occurred.

The situation in coastal aquaculture, specifically the shrimp aquaculture sector, is quite different. Since the early days of investment into this activity, there has been an effort by government authorities to maintain a sensitive attitude towards the environment, especially as it was possible to benefit from hindsight and avoid some of the errors made in other parts of the world. This focus has increased as the shrimp aquaculture sector has made a virtue of its environmental credentials which have played a key role in disease control and in efforts to gain recognition for a premium product in export markets. Initial guidelines were created in 1998 and are known as the Management Scheme for Shrimp Aquaculture (*Schéma d'aménagement d'aquaculture de crevette* or SAAC). As the national policy towards shrimp culture evolved, a separate law was passed in 2001, relating to responsible and sustainable aquaculture development (Madagascar, 2001). This is much more detailed than the EIA regulations which were adopted first in 1999 and revised in 2004, and makes the assumption that both industrial <u>and</u> artisanal aquaculture would be subjected to full EIA. To what extent the "artisanal" farmer has the means to undertake a complete EIA study is not discussed.

In the context of biodiversity, the issue of introductions is more clearly defined. From the way the article 4/annex 1 of the EIA law is phrased, anyone planning to introduce a species into an aquaculture project (whether an alien species or moving a native species out of its established range) will be obliged by law to carry out an EIA. This also applies to GMOs. There is no guidance, in the decree or in the aquaculture guidelines, as to how this might be carried out or definition of the criteria that must be satisfied in order for approval for the introduction to be given. The issue of how far an individual project EIA might be able to satisfactorily tackle the wider biodiversity issues of a species introduction is discussed elsewhere in this paper.

Madagascar is fairly unique in the extent of guiding documentation that has been published by the Office nationale pour l'environnement – National Environment Office (O.N.E.) to assist in the interpretation of the laws; this includes general guidance for

EIAs (O.N.E., 2006a) as well as specific advice contained in guidelines for carrying out aquaculture EIA (O.N.E., 2005). Although this guideline document is entitled as being relevant to "aquaculture projects", the content is clearly moulded primarily by the approach of the shrimp culture industry. Applying such a rigorous schema to all types of aquaculture might not be possible or cost effective, and the authorities will need to apply discretion as new types of aquaculture activity attract investment.

Madagascar has published a number of other useful guidelines, see Table 5. These include one targeting existing projects which under the regulations should also undertake studies similar in scope to EIA, in a process called **Environmental Conformity**. Although not yet used for aquaculture, this regulation also applies retrospectively to new projects that have failed to follow correctly the EIA process, although they should have done so by law. There is another set of guidelines for carrying out an **Environmental Audit.** These are not a fixed legal obligation (although there are situations in which an audit can be demanded by the authority), but the audit is proposed essentially as a tool for businesses and projects wanting to improve their environmental credentials. The approach is not dissimilar to EIA. Although these guidelines are comprehensive they do not establish any actual national numerical standards for most of the common environmental parameters such as water quality, and these are left to local review for each project.

Of particular note is the publication of guidelines for those with the responsibility for appraising an EIA report. Interpretation of law is important, and as this is something that will evolve over time, publication of the official approach to interpretation is a significant step, as this guide is also available to promoters and EIA consultants as well as staff of the reviewing authority. This should give all the "stakeholders" of an EIA a better chance to understand the process and each other. This is a document that will need to be regularly updated as new situations are encountered.

An important part of any EIA report is the proposal of mitigation measures and of monitoring of key environmental parameters that are identified in the report as being of potential risk. This is included in the statutes as the PGEP (Project Environmental Management Plan) which needs to be approved and validated by the environment authority alongside a quantified statement of the project's environmental commitments (*Cahier des charges environnemental* - CCE) for which progress must be regularly reported to the agency. A typical document will indicate which parameters should be

TABLE 5
Guidelines for environmental issues with relevance to aquaculture, as published in Madagascar

Scope	Title
Shrimp culture development	Schéma d'Aménagement d'Aquaculture de Crevette (SAAC). [Shrimp aquaculture management scheme]
Code of Conduct for sustainable shrimp culture	Code de Conduite pour le Développement d'une Aquaculture de Crevette Responsable et Durable (Madagascar and GAPCM, 2005). [Code of Conduct on the Development of Responsible and Sustainable Aquaculture]
General EIA	Directive Générale pour la Réalisation d'une Etude d'Impact Environnmentale (O.N.E., 2006a). [General guideline for the conduct of an environmental impact study]
General EIA	Présentation du Décret MECIE (O.N.E., 2006b). [Presentation of the Decree MECIE]
Aquaculture EIA	Guide pour la Réalisation d'une Etude d'Impact Environnementale des Projets Aquacoles (O.N.E., 2005) [Guide for the conduct of an environmental impact study of aquaculture projects]
Environmental Audit	Audit Environnemental: Guide Général (O.N.E., 2007a) [General guide to environmental audit]
Environmental Conformity (of existing projects)	Mise en Conformité: Guide Général (O.N.E., 2007c) [General guide to environmental conformity]
Evaluation of EIA reports	Guide d'Evaluation des Etudes d'Impacts Environnementaux (O.N.E., 2007b). [Guide for Evaluation of EIA reports]

monitored without necessarily determining the acceptable levels of these parameters. Here the promoter is asked to compare the measurements with the pre-project levels. In fact even the most careful management will have some impact on the environment; it is important to eventually define how much change is considered tolerable. This is an aspect which can be improved in future with the acquisition of experience.

Public participation/consultation is a clear requirement in the statutes and all promoters must undertake this. The complete process for the different levels indicated for the public consultation should take within a period of 10 to 70 days. During this time the public may consult "documentation", including a summary written in accessible non-technical language. Specific reference is not made to the access to the EIA report itself, and this is not statutorily put into the public domain. Experience shows that it is not easy to gain access to this document after the process is completed.

Effectiveness and future development of EIA

As one of the countries with the most experience of EIA, Madagascar also provides to some degree an opportunity to gauge its effectiveness, because it has been carried out for several aquaculture projects. The situation is rather unusual in that so far it mainly involves a focussed group of investors (shrimp aquaculture in mangrove areas of north west Madagascar) who have been pro-active in promoting their environmental credentials, and in this respect they have probably always been ahead of the evolution of the national regulatory process. To date, it is clear that the industry sector's close attention to environmental management, which includes the strict adherence to EIA as part of the process, has contributed to the current success of the aquaculture projects at several levels: avoidance of negative environmental impact, successful technology maintaining a quality disease-free production and international market recognition of a premium product.

The degree to which EIA can be credited with avoiding negative environmental impact, which might otherwise have occurred, remains to be tested with time. Certainly it would appear that the environmental policy adopted in this case has succeeded so far in that the Malagasy industry has not experienced the problems that the shrimp industry has experienced elsewhere, such as South and Southeast Asia, where initial development was not sufficiently controlled. Madagascar farms remain essentially disease-free. Long term damage to the mangrove ecosystem has been minimal, and with targets for re-afforestation included in the EIA's mitigation measures, there may be areas where there have even been improvements in mangrove habitat.

Environmental assessment has been extended here to include the wider implications of the effect of the projects on local demographics and social welfare, and the possibility that these may in turn lead to impacts on the coastal environment. It has been suggested that a successful shrimp farming industry, providing jobs and improved community infrastructure, against a national background of insufficient employment opportunities, is likely to become a magnet driving population movements significantly greater than just the increase in employment in the industry itself. This raises the possibility that this could lead to the growth of large new "pioneer" towns close to the sensitive coastal habitats on which the industry depends (Gruzen, 2005). Monitoring and periodic reappraisal of the immediate environment of these projects will provide the long term answers to the benefits of the EIA process.

The semi-intensive techniques being used for *Penaeus monodon* culture and the high quality disease free environment maintained on the farms, have contributed to a product that has become recognized as one of the best in a competitive international market where they command a significantly higher than average price. This has led to one farm gaining official recognition in the French market where it has been awarded the "Le Label Rouge", a premium label. Another farm has been awarded "organic status" for its products.

Ecocertification

The next step planned by the Malagasy association of shrimp farmers/fishermen (Groupement des Aquaculteurs et Pecheurs de Crevettes de Madagascar, GAPCM) is to develop a national ecocertification procedure to maintain these standards, and serve as a base for market promotion. This will build on principles and recommendations provided by a consortium of international agencies promoting sustainable approaches to shrimp culture (FAO/NACA/UNEP/WB/WWF, 2006). The Consortium is composed of FAO, the Network of Aquaculture Centres in Asia-Pacific (NACA), the United Nationsl Environment Programme (UNEP), World Bank and the World Wildlife Fund (WWF), and it is the WWF that has been collaborating with the GAPCM in developing a version of the principles adapted to the Malagasy situation. The criteria used for eco-certification will be based on the principles outlined by the Consortium in eight main areas: farm siting, farm design, water use, broodstock and postlarvae, feed management, health management, food safety and social responsibility. EIA will remain integral to the decision-making process of creating shrimp farms, and the guidelines for EIA as well as for the Environmental Management Programmes that are agreed following approval of the EIA studies, are being harmonised with the criteria adopted for the eco-certification procedure. This will include a number of published standards of technical parameters that must be met, as well as greater clarification of issues such as use of antibiotics, which are important both in terms of bio-safety as well as customer perceptions of "green credentials". Criteria for social responsibility are expected to be given greater attention at the EIA stage, as well as during project operations.

The drive to develop regulations for shrimp aquaculture has resulted in statutes which are well adapted to this particular case – a high value product produced in a sensitive habitat with an international conservation spotlight focussed on it. It is not certain that the same approach is applicable to all aquaculture in Madagascar, especially when one considers its development in an agricultural or semi urban landscape in freshwaters or coastal areas. To deal with this, the environment authorities will need to show flexibility, adapting guidelines and interpretation of the laws to a wide variety of situations that currently include: rice/fishculture, seaweeds, *Spirulina*, small-scale hatcheries, molluscs, sea cucumbers and cage culture. Some of this is already considered in the guide for the evaluation of EIA dossiers (O.N.E., 2007b).

Cost and bureaucracy can be powerful dissuasion to people entering the sector, particularly at the small-scale end of the spectrum. The regulations include fees to be paid to the official institutions to cover costs of oversight of EIA and Project Environmental Management Programmes (or PGEP), as well as public hearings. These are calculated as a proportion of total investment and can be over 0.5 percent of the total cost of smaller projects. The shrimp management plan deliberately sets very high environmental standards, which would be very difficult to meet for unskilled artisanal operators with limited financial means. This is seen as necessary to maintain industry disease-free conditions, with uncontrolled small-scale operators being potentially a risk due to inadequate management. In other cases there is a likelihood that semi-intensive or artisanal farmers would be subject to "lighter" solutions that would be more appropriate to their situation (e.g. PREE rather than EIA, or simple authorization of an application).

NIGERIA

Brief background

Nigeria provides one of the brightest examples of progress in aquaculture on the African continent, as can be seen by the rapid growth of this sector in the past 15 years. Although the practice has existed for over 50 years, the level of production has remained very modest for most of this time, particularly when one considers the size and population of the country. Current production is considerably over 50 000 tonnes annually and recent inventories of aquaculture activity have recorded over 2 500 fish farms in the country, a number which is growing rapidly and stimulating many related activities such as fish feed production by over 200 feed mills (Miller, 2006). Traditionally fish farming was carried out using extensive or semi-intensive techniques, mostly in fish ponds, but the methods employed now include ponds, dams, cages, tanks, raceways, re-circulating systems and rice paddies. The potential for even greater growth is evident given the market demands of a growing, increasingly urban population, complemented by a dynamic fabric of small-scale enterprise (Ohen and Dixie, 2006).

The increase in aquaculture activity is mostly accounted for by the introduction and spread of techniques for the production of *Clarias*, the African catfish. Production has been increasing rapidly by about 20 percent per year as producers have moved to supply markets in the many urban centres. Market demand remains strong as a number of factors encourage continuing growth – such as the positive image of the catfish among consumers in many areas of Nigeria, and the possibility of distributing live fish to market which reduces reliance on cold chains. The techniques being used are very varied. At one end of the spectrum, semi-intensive farming in large and small ponds is preferred, particularly in rural areas where there is sufficient land available, as well as on some large private farms. However, there is increasing use of more intensive grow-out systems in concrete tanks, raceways and sophisticated re-circulating water systems. These "high-tech" farms, both large and small-scale, require less land and are being built close to, or even within, the main urban areas.

Another important characteristic of recent development has been the increasing sophistication of the complete supply and marketing chain. Although some farmers are virtually independent for all their requirements, there are more and more specialists in the chain, including fry producers, fish-feed producers, equipment suppliers, wholesalers and processors, new market structures and even specialized fast food chains using the product.

The move to more intensive methods, along with parallel increases in the allied activities, will certainly raise significant issues in the future as far as the environment and EIA are concerned. This will be particularly so in the new developments in the urban and "peri-urban" settings, where the farmers will face environmentally related challenges both in how their activities affect their very close residential/industrial neighbours, and also in how the quality and quantity of essential resources – especially of water – are affected. For the time being, however, aquaculture continues to be perceived a "low-risk" activity.

Legislative background

Nigeria has developed its legislative framework for environmental management over a number of years, and was one of the first African countries to give significant emphasis to specialized environmental institutions. The country has some of the most important industrial concentrations on the continent – particularly with all the allied activities to the oil and petroleum industries, and it is as a consequence of these that there has been increasing political and social awareness of environmental issues. An incident of toxic waste dumping from foreign sources was the trigger in 1988 for the government to put in place legislation to govern environmental management along with the creation of a specialized institution to oversee and implement the legislation – the Federal Environment Protection Agency (FEPA).

Since that date, the principle of environmental protection has been enshrined in the Federal Constitution of 1999 which contains provisions for the protection and improvement of the environment and safeguarding of water, air and land, forest and wildlife of Nigeria (Makinde and Ayanbule, 2006).

Nigeria's National Policy on Environment (1989) sets out the following goals (Anago, 2002):

- securing the quality of the environment for health and wellbeing;
- conserving and using the environment and natural resources for the benefit of present and future generations;
- restoring, maintaining and enhancing the ecosystem and ecological processes essential for the functioning of the biosphere to preserve biological diversity and the principle of optimum sustainable yield in the use of natural resources;
- promoting public awareness on the link between development and the environment;
- international co-operation with countries and international organizations in the protection of the environment.

The Federal Government of Nigeria has promulgated different laws and regulations to safeguard the environment. These include the following of relevance to EIA in aquaculture, although there are overlapping statutes and guidelines which apply mainly to the oil industry:

1. Federal Environmental Protection Agency Act of 1988 (FEPA Act). The following Regulations were made pursuant to the FEPA Act:
   (i) National Environmental Protection (Effluent Limitation) Regulations;
   (ii) National Environmental Protection (Pollution Abatement in Industries and Facilities Generating Wastes) Regulations; and
   (iii) National Environmental Protection (Management of Solid and Hazardous Wastes) Regulations.
2. Environmental Impact Assessment Act of 1992 (EIA Act).
3. Harmful Wastes (Special Criminal Provisions etc.) Act of 1988 (Harmful Wastes Act).
4. The National Environmental Standards and Regulations Enforcement Agency Act 2007 (NESREA Act).

The different States within Nigeria also have the power to make laws to protect the environment within their respective jurisdictions; e.g. in Lagos State, there is the Environmental Protection Agency Law Cap L23, Laws of Lagos State of Nigeria, 2003; and in Akwa Ibom State, there is the Environmental Protection and Waste Management Agency Law, Cap 47, Laws of Akwa Ibom State of Nigeria 2000.

Nigeria is also committed to a wide range of international environmental and biodiversity agreements that could affect the way choices are made for aquaculture development in general, as well as the particular aspects of an EIA (Anago, 2002).

These include:

- 1968 African Convention on Conservation of Nature and Natural Resources;
- 1972 UN Conference on the Human Environment (Stockhom declaration) which established the nexus between development and environmental integrity;
- 1992 UN Conference on Environment and Development (Rio Summit), which produced a suite of five documents:
  - Agenda 21– an action plan for sustainable development in the 21st century;
  - The Rio Declaration – Principles on healthy environment and equitable development;
  - The Convention on Biodiversity;
  - The Convention on Climate Change;
  - A statement of Forest Principles.
- 1993 Lugano Convention on Civil Liability for damage resulting from activities dangerous to the Environment;
- Kyoto Accord/Kyoto Protocol on global warming;
- African Charter on Human and People's Rights;
- Abuja Declaration – Fish for All Summit, hosted by Nigeria - demanded good environmental management in aquaculture (NEPAD, 2005).

Thus it is clear that Nigeria has extensive statutory instruments in place with which to implement and enforce many aspects of environmental management. For this review, the key statute in this collection is the Environmental Impact Assessment Act of 1992 (FAO, 2006-2008. NALO Nigeria).

Institutionally the application of the EIA statute has been the responsibility of the Federal Environmental Protection Agency over most of the time since 1992. This was an independent agency, attached to the Federal Presidency. Recent institutional changes have occurred which moved the agency into the Federal Ministry of the Environment, and in 2007 FEPA was abolished and replaced by the National Environmental Standards and Regulations Enforcement Agency (NESREA).

The NESREA Act repealed the FEPA Act and established the NESREA in its place (Nigeria, 2007). The new agency has responsibility to enforce compliance with environmental standards, regulations, rules, laws, policies and guidelines. NESREA is also responsible for the protection and development of the environment, biodiversity conservation, sustainable development and the development of environmental technology (Awogbade *et al.*, 2008).

The EIA process as laid down by the Act is defined in fairly standard terms, and these are summarised in Box 4 as an example of similar procedures followed in other case study countries (Echefu and Akpofure, 2002). Under the Act, FEPA published various sectoral EIA procedures together with EIA Procedural Guidelines in 1995.

The liability of aquaculture projects to EIA is determined by the priorities given to different categories of development activity by the Nigerian government. The Act defines three categories – High Risk, Low Risk and No Significant Impact – see Table 6. In theory aquaculture can be interpreted as being in either category

TABLE 6
Categories used for screening for liability to EIA, Nigeria

Category 1 **High risk of environmental impact**	**Category 2** **Low risk activities**	
EIA mandatory	**EIA only when required by the Authority**	**However liable to EIA if project is sited in/close to:**
• Agriculture/agro-allied • Fisheries • Forestry • Industry (manufacturing) • Food, beverages and tobacco processing • Infrastructure • Ports • Housing • Airport • Drainage and irrigation • Railways • Transportation • Resort and recreational development • Power Generation • Petroleum • Mining • Quarries • Waste treatment and disposal • Water supply • Land reclamation • Brewery	*Agriculture and rural development* • Any reforestation / afforestation project • Small-scale irrigation and drainage • Small-scale aquaculture and mariculture • Saw-milling and wood logging • Rubber processing • Any fish processing • Any other agro-allied *Industry and infrastructure* • Mini hydro-power development • Any small-scale industry development • Small-scale power transmission • Any renewable energy development • Telecommunications facilities • Rural water supply and sanitation • Public facilities (hospitals schools and housing) • Small-scale tourism development • Road rehabilitation • Any form of quarry or mining	• Environmentally sensitive areas • Coral reefs • Mangrove swamps • Small islands • Tropical rainforest areas with erosion prone soils • Mountain slopes areas prone to desertification • Natural conservation areas • Wetlands of natural or international importance • Areas with protected/ endangered species • Areas of unique scenery • Areas of particular scientific interest • Areas of historic/archaeological interest • Areas of importance to threatened ethnic group

Source: adapted from Nigeria, 2007

BOX 4

EIA process in Nigeria

The proponent initiates the process in writing to the responsible officer. A notification form is duly completed with all relevant information on the proposal:

- magnitude – probable severity of each potential impact;
- prevalence/extent and scope – extent to which the impact may eventually extend;
- duration and frequency – is activity short term, long term or intermittent;
- risks – probability of serious environmental effects;
- significance/importance – value attached to a specified area;
- mitigation – measures available for associated and potential environmental effects.

NESREA does internal screening to determine the project's category under the mandatory study activities list. Where no adverse environmental effects exist, the Environmental Impact Statement (EIS) is issued and the project commences with appropriate mitigation and monitoring measures. Otherwise within ten working days of receipt of the proposal, the screening report is sent to the proponent for scoping and the preparation of terms of reference. The Terms of Reference embody the scope of the proposed EIA study and this is examined and the scope of the study defined accordingly by NESREA. The proponent carries out the study, generally using consultants, and the draft EIA report in 15 copies is submitted to the responsible officer. For this draft report to be complete it must as an annex record the results of public participation in a public form.

Within 15 working days of the receipt of the draft report, NESREA concludes evaluation of the draft and determination of the review method which it communicates to the proponent in writing. The four methods are:

- in-house review;
- panel review (sitting may be public);
- public review – an elaborate display of the report for 21 working days with appropriate display venues chosen by NESREA for the convenience of the public stakeholders and communities. Through newspaper advertisement NESREA invites interested groups/persons to participate;
- mediation.

Within one month of the review process, review comments are furnished to the proponent. In this review stage, the public participates only when NESREA's chosen method of review guarantees its participation. The final EIA report, addressing and proffering answers to review comments, is submitted within six months to the responsible officer. At this early stage, and on mutual agreement, NESREA and the proponent set conditions establishing a follow-up programme (mitigation, compliance and monitoring plan), a monitoring strategy and audit procedure. A "no project' decision is communicated to the proponent if the review comments are adverse and/or improperly addressed in the final report and the final EIA report is unsatisfactory. The decision-making body is the NESREA technical committee chaired by the Director General/Chief Executive.

Within one month of the receipt of a final EIA report which has been adjudged as satisfactory, the committee approves and issues the environmental impact statement followed by certification by the responsible officer complete with appropriate conditions and with a validity period. Armed with the certificate, the proponent commences the project subject to the conditions and specifications contained in the environmental impact statement. If the project is not commissioned within the validity period on the certificate, a revised and updated EIA report becomes necessary for revalidation.

The progress of the project is monitored to ensure compliance with all conditions and mitigation measures. Environmental audit, assessing both positive and negative impacts of the project, is carried out periodically. In its exercise of discretionary powers, FEPA refers any project likely to cause significant environmental effects that may not be mitigated (or where public concern about the project warrants it) to the NESREA council for mediation or panel review.

1 (fisheries) or category 2. Category 2 only includes small-scale activities without defining the boundaries between large and small-scale. In practice it seems that the trigger point used is 50 ha of production area. This in fact rules out almost all the existing farms, which would not be liable to mandatory EIA, unless they are sited in one of the defined environmentally sensitive areas. This type of trigger point is not fully relevant to the type of intensive production unit now being created, which have significant production volumes on areas much less than 50 ha. It may be reasonable to assume that the more intensive methods carry a higher level of environmental risk than a more extensive pond-based system.

The perception that aquaculture is low-risk means that few producers feel very concerned by this legislation, and indeed the use of full EIA is not the norm for individual aquaculture farms. This position of low priority is reinforced by the far greater and very real problems faced by Nigerian society and the institutions charged with enforcement of environmental legislation when dealing with the threat of environmental impact from industry – most especially the oil industry. Most aquaculture producers do not engage with the EIA process at all; some of the larger investors are able to obtain an EIS and clearance to proceed with only a brief preliminary assessment/application to either a state agency or to FEPA.

This relatively light handed approach to aquaculture would seem to be a quite rational one in the circumstances, and a position that in the short term is contributing to (or at least not detracting from) the forces favourable to the continuing growth of the aquaculture sector in Nigeria. It is reasonable to consider aquaculture as low-risk in general. While the current policy gives investors the benefit of the doubt in terms of environmental risk, it is nevertheless clear that the statutes are largely in place to deal with any negative situation should anything go wrong, should permits be abused or should the combined numbers of farms create an aggregate impact that cannot be tolerated without some mitigation. The EIA law is also ready to be invoked in sensitive areas for such cases as shrimp farming proposals in mangroves or constructing farms in important wetlands.

Monitoring of the impact of a project on the environment, and the option of periodic audit at the request of the Agency, are measures that are included in the EIA Act. Actual cases of obligatory monitoring are not documented, and it seems likely that only parameters that are of immediate benefit to the farm operation are being monitored by farm managers with any consistency.

Reports of the EIA process as used outside the aquaculture sector have identified a number of difficulties in the implementation of the law, and in general the quantity of EIAs undertaken is well below what might be expected. These problems may have some relevance to aquaculture, and are recognisable as actual or potential difficulties encountered in other countries as well. Many of these are institutional problems, and one of the major challenges relates to the relationship of FEPA with other ministries and public institutions (Adegoroye, 1994; Adegoroye, 1996; Echefu and Akpofure, 2002). The introduction of the environment laws/agency in 1988 created a new framework, without necessarily modifying and adjusting the role and legislation of existing (and often more powerful) institutions. The result was that there were overlapping statutes and interests in such matters as water, land and especially the management of the oil industry, and being more entrenched in the system these have continued to control many aspects of environmental management to the detriment of FEPA's capacity to intervene. A further complication in Nigeria is overlap with state responsibilities in these same domains, and a lack of cooperation with states when they are not associated with an EIA until late in the process when the EIA documents are being reviewed. Sometimes the will of the political establishment is called into question, when powerful institutions or individuals are able to intervene to bypass the EIA process using diverse development priorities as justification (Adegoroye, 1994).

SOUTH AFRICA

Brief background

South African aquaculture has a long history, going back to the 1890s when trout were introduced, but for a long time it did not become an important activity and has only recently attracted a lot more attention making it one of Africa's top producers. Early fish farming was entirely in fresh water, using mainly trout at a small-scale, with more recent interest in tilapias, catfish and ornamentals. Many of these initiatives used introduced species of fish, several of which have now established populations in the wild. Freshwater crayfish production has also been on the increase and eel production is being developed. More recently, there has been increasing interest in marine aquaculture which has now overtaken freshwater production in both quantity and value.

Molluscs – abalone, oysters, mussels – are the most valuable products, although shrimp farming projects and seaweed production are now expanding. There is one project developing open-sea cage culture of Atlantic salmon, and other indigenous marine finfish are currently being researched for culture.

In summary, the South African aquaculture sector is developing fast, with a varied multi-species base in freshwater, brackish-water and marine environments using a range of methods from the extensive to very intensive. Some project proposals are very ambitious and their scale suggests that these may require close attention to their potentially significant environmental, social and economic impacts.

Legislative framework for environmental assessment

Background

South Africa has a well developed legal system and since the change to full democracy there has been an opportunity to revise many laws and regulations: this gives the national legislation a modern outlook that is reflected in the treatment of environmental concerns. The most fundamental expression of this is in the environmental provisions that are included in the Bill of Rights in Chapter 2 of the Constitution of South Africa Act which states:

Everyone has the right –

(a) to an environment that is not harmful to their health or well-being; and

(b) to have the environment protected, for the benefit of present and future generations, through reasonable legislative and other measures that –

(i) prevent pollution and ecological degradation;

(ii) promote conservation; and

(iii) secure ecologically sustainable development and use of natural resources while promoting justifiable economic and social development.

This amounts to a near perfect defining justification for EIA.

As a result of these ideals the government has sought to integrate environmental responsibilities across many sectors of national, provincial and local government.

EIA regulations are new in South Africa, but the process has been supported for some years on a voluntary basis within the context of the now repealed Environment Conservation Act of 1989.

Aquaculture and environmental legislation

The principal laws governing the environment that impinge on aquaculture, and hence must be taken into account during EA for any new activity, are:

- National Environmental Management Act of 1998; *(general framework);*
- National Environmental Management: Biodiversity Act of 2004; *(focused on biodiversity – including issues of introduced species, GMOs);*

- National Environmental Management: Protected Areas Act of 2003; *(identifies sensitive areas for special protection);*
- "(EIA) Regulations in terms of Chapter 5 of the National Environment Management Act, 1998" of 2006; *(EIA regulations);*

The Environmental Management Act spreads environmental responsibility widely through the sectoral departments, with a coordinating role for the Minister of Environmental Affairs and Tourism who is responsible for the National Environmental Advisory Forum and the Committee for Environmental Coordination. Departments (national and provincial) whose activities have an impact on the environment or who are responsible for environmental management participate in these coordination bodies, and must produce and regularly update an environmental implementation plan or an environmental management plan, respectively.

New draft regulations propose to widen the scope of the articles of the Act concerning EIA to include:

(i) environmental management frameworks;
(ii) strategic environmental assessments;
(iii) environmental impact assessments;
(iv) environmental management plans;
(v) environmental risk assessments;
(vi) environmental feasibility assessments;
(vii) any other relevant environmental management instruments that may be developed in time.

However, aquaculture is not administered within just one sector and regulation as well as policy, promotion and development are quite fragmented across more than one ministry and several sectoral departments. Each of these is backed by sector legislation with some application to aquaculture. At present, the legislation controlling freshwater aquaculture is administered by three lead departments (DEAT, DOA, DWAF)[6], while mariculture is overseen primarily by DEAT.

Other departments – Department of Land Affairs, National Port Authority (marine waters leasing), Department of Trade and Industry and Department of Health also administer legislation that impacts directly or indirectly on aquaculture. Although not expressly environmental in intent, this legislation is also relevant to EIA studies dealing with aspects of social and economic environments – alternative land uses, impacts from supply chain development and disease transmission for instance.

These diverse Acts are not integrated and this has created a situation where no single department has either the mandate or the capacity to provide the one stop service that the sector would need to rationalize the procedures.

(i) DEAT administers Acts that deal with the sustainable use of natural resources:
- The National Environmental Management Act, 1998;
- The National Environmental Management: Biodiversity Act, 2004;
- The National Environmental Management: Protected Areas Act, 2003;
- The Marine Living Resources Act, 1998 *(fisheries, mariculture).*

This is the legislation that essentially governs the processes of environmental assessment, including EIA.

(ii) DOA legislation deals with the sustainable use of agricultural resources (AAPD, 2006):
- Conservation of Agricultural Resources Act, 1983 (zoo-sanitary and phyto-sanitary control);
- Agricultural Pests Act, 1983 (pests and chemical use);

[6] DEAT: Department of Environment Affairs and Tourism
DOA: Department of Agriculture
DWAF: Department of Water Affairs and Forestry

- Animal Diseases Act, 1984 (diseases, animal movements);
- Animal Improvement Act, 1998 (importation of animals and genetic material, genetic improvements, strains);
- The Genetically Modified Organisms Act, 1997 (introduction and testing of GMOs).

Any agricultural development involving freshwater aquaculture would be subject to this legislation as well as the DEAT legislation. In addition, any movement of aquatic animals would be subject to both DOA and DEAT legislation requiring more than one permit.

(iii) DWAF in turn administers legislation that provides for the management of water resources:

- The National Water Act, 1998 (Act No. 36 of 1998)

Water is a key and usually scarce resource in South Africa and its use is strictly regulated by water sector institutions (DWAF, 2007). Many water uses require a "water use licence" in terms of this Act. This includes some similar information as for an EIA to be provided and section 41(2) requires "the applicant (for a licence), at the applicant's expense, to provide ...an assessment by a competent person of the likely effect of the proposed licence on the resource quality;" One can assume that most freshwater aquaculture activity using resources or impounding water would therefore be subject to this legislation as well.

Environmental laws are administered at several levels: national/state, the province and the municipality level. National level institutions are responsible for issuing the general regulation for EIA and the national guideline. The provinces are responsible for the bulk part of EIAs. But where the national environment is affected, or national governmental bodies are the applicant, the authority moves up to the national level (DEA&DP, 2006f; South Africa, 2006b). The authority can also be given to the local municipal authorities.

The screening of aquaculture for EIA liability in South Africa

The screening of projects for environmental regulation in South Africa is progressive and flexible. There are three main outcomes from screening:

- No further assessment;
- Basic Assessment;
- EIA / Scoping Report

The EIA regulations provide two lists: Listing 1 which indicates the activities that would normally only require a Basic Assessment; generally each category has a minimum size threshold for inclusion and below this threshold no assessment is needed (although other permits may still be required). Activities included in Listing 2 will normally require a Scoping Report and full EIA study (South Africa, 2006a).

Aquaculture is explicitly included as follows in Listing 1 and so normally liable for a Basic Assessment:

"Activity 1 (i): The construction of facilities or infrastructure, including associated structures or infrastructure, for aquaculture production, including mariculture and algae farms, with a product throughput of 10 000 kgs or more per year;"

The aquaculture project may also be liable to a basic assessment because it meets other category definitions such as: dams and reservoirs over 50 000 m^3, certain construction or earth moving activities in the sea or within 100 m inland of the high-water mark of the sea, or the release of GMOs into the environment.

However, an aquaculture project may be liable for a full EIA if the project:

"Involves building a dam over 5 m high, certain construction or earth moving activities in the sea or within 100 m inland of the high-water mark of the sea, or the introduction of an alien species".

Or it may need an EIA purely because of its size:
"Any development activity, including associated structures and infrastructure, where the total area of the developed area is, or is intended to be, 20 ha or more."

Key points of the EIA process in South Africa

It is necessary to apply for an environmental authorization for any activity that falls into a category included on Listing 1 or Listing 2 of the regulations, or for any other activity with potentially significant environmental impacts. Obtaining the authorization depends on successful review of either a Basic Assessment Report or a full EIA Report. There is a procedure by which exemption from this process can be obtained in exceptional circumstances. It is worth noting here that the Basic Assessment is not a summary form filling screening exercise that is stipulated in some other national regulations, but is an assessment process that is akin to a streamlined EIA and requires key inputs such as stakeholder/public consultation and is normally carried out with the assistance of an environmental assessment practitioner (EAP).

Basic Assessment is applied to smaller scale activities, the impacts of which are generally known and can be easily managed. Typically, these activities are considered less likely to have significant environmental impacts and, therefore, do not require a full-blown EIA.

A Basic Assessment Report is a more concise analysis of the predicted environmental impacts of the proposed activity than Scoping EIA Reports. However, Basic Assessment still requires public notice and participation, consideration of the potential environmental impacts of the activity, assessment of possible mitigation measures and an assessment of whether there are any significant issues or impacts that might require further investigation. If the competent authority (national or provincial) is unable to make a decision based on Basic Assessment Report alone, they may request that an applicant undertakes the more thorough scoping and EIA process.

Scoping and EIA requires a thorough environmental assessment for activities contained in Listing 2, which are those activities that (due to their nature and/or extent) are likely to have significant impacts that cannot be easily predicted. They are therefore higher risk activities that are associated with potentially higher levels of pollution, waste and environmental degradation.

A Scoping Report (including plan of study) requires a description of the proposed activity and any feasible and reasonable alternatives, a description of the property and the environment that may be affected and the manner in which the biological, social, economic and cultural aspects of the environment may be impacted upon by the proposed activity; description of environmental issues and potential impacts, including cumulative impacts that have been identified, and details of the public participation process undertaken. In addition, a Scoping Report must contain a roadmap for an EIA, referred to as the "Plan of Study for the EIA", specifying the methodology to be used to assess the potential impacts, and the specialists or specialist reports that will be necessary.

An applicant may only conduct an EIA after the competent authority has approved the Scoping Report and the Plan of Study for the EIA. The scoping and EIA process culminates in the development and submission of the EIA Report and the Draft Environmental Management Plan to the competent authority. The Environmental Authorization specifies amongst other details the period of validity, conditions that must be complied with before the activity begins, requirements for monitoring and environmental audits and requirements for financial or other security to cover the risks to the state and the environment for non-compliance.

Approach to biodiversity issues

One of the important potential environmental impacts of the aquaculture sector comes from introducing species alien to the local ecosystem. In the past there has been significant interest in importing alien species, and most current aquaculture operations depend on them. Importing a species is almost certainly taking a risk of introducing it into the wild, as it is probable that whatever the security arrangements on farms there will be escapes, and given the right conditions the introduced species will establish wild populations with consequences for the local species and ecosystems. The widespread introduction of alien fish such as trout and carp into South Africa's rivers, streams and dams and the translocation of indigenous fish between catchments are reported as having had an extremely serious impact on native fish species (DEAT, 2005). It is possible for the impacts resulting from an introduction to be catastrophic to the indigenous biodiversity, although equally there may at the same time be positive economic benefits.

Given this potential for environmental impacts, it is possible that any species introduction could be interpreted by the Minister as requiring an EIA to be carried out in the terms of the EIA regulations. However, alien introductions are not specifically mentioned in the regulations, just as EIA is not specifically required under the new Biodiversity Act in which the issues of introductions and translocations are dealt with. Under the latter Act there are substantial controls on all introductions and use of alien species, as well translocations out of natural range, in terms that are not dissimilar to those used to frame the EIA process:

"A person may not carry out a restricted activity[7] involving a specimen of an alien species without a permit…

A permit… may be issued only after a prescribed assessment of risks and potential impacts on biodiversity is carried out".

Under these rules for biodiversity, the decision is vested principally in the Minister, with less detailed regulation of the decision making process than for EIA. The process is less open than EA and public and stakeholder participation, for instance, is not as comprehensive as that prescribed in the EIA regulations, although there is provision for consultation and for objections to be made in writing to the Minister.

There is however a further article in the Biodiversity Act that may well make investors think hard before proposing the importation of a new alien species:

"Should an alien species establish itself in nature as an invasive species because of the actions of a specific person, a competent authority may hold that person liable for any costs incurred in the control and eradication of that species".

This could become a substantial financial risk for an investor to consider as testified by current endeavours in South Africa to control or eliminate invasive aliens. South Africa is unusual in Africa in putting significant resources into controlling invasive species and there are attempts to quantify the costs of dealing with the consequences of uncontrolled introductions. The cost to clear the alien plant invasions in South Africa is estimated to be around R12 billion (1.6 billion US$), or roughly R600 million (80 million US$) per year for the estimated 20 years that it will take to deal with the problem (DEAT, 2005). The total cost to the nation could be much higher as there are often extremely serious, negative impacts on the trade, tourism, construction, health, fisheries, forestry and agriculture sectors. It is of note that DEAT have indicated that marine ranching would require full EIA based largely on biodiversity issues (DEAT, 2006b).

[7] Restricted activity includes: importing, possessing, growing, breeding, moving, selling an alien species

Improving the EIA process

Human resources

The promulgation of the EIA Regulations and the requirement that Basic Assessments and EIA applications must now be managed by recognized environmental assessment practitioners (EAP), has acted as a catalyst to growth within the environmental assessment profession. This has prompted a plan to introduce a minimum standard for competence in this profession and, through certification, to introduce some measure of quality assurance and to satisfy the regulatory requirement for practitioners.

There are three main bodies which maintain (voluntary) registers of professionals who can practice as EAPs (Brownlie, 2006). The ICB/CBEAPSA[8] is the specialized body for EA and had 87 registered members in 2006. Two other bodies register professionals with primarily a natural resources speciality[9].

Qualifications for recognition vary and practitioners come from university level training in different relevant fields, e.g. natural sciences, human and social sciences, built environment, mining. As far as specialized input to EIAs for aquaculture projects is concerned Fisheries, aquaculture and marine sciences are taught in a number of universities and institutions in South Africa. Specialized EIA courses are available in over 20 universities and training institutions.

Guidelines

In the past two years there have been a number of EIA guidelines published by government departments involved in environmental regulation. Some of these provide detailed information for carrying out EIAs in various situations, although there are four documents specifically providing guidance for aquaculture (see Box 5). An important part of these guidelines is information about the various different permits and approvals that must be obtained in starting a commercial aquaculture operation.

Multiple legislation: EIA in a complex framework

As can be seen from the above information, aquaculture investors are faced with a quite complex "web" of regulation and guidance. The current more comprehensive environmental laws, including the EIA regulations are very recent and it is too early to draw conclusions on efficacy. However, overall regulation is still open to criticism by producers that it is complex with insufficient integration between sectors involved and that unrelated sectoral statutory frameworks and procedures have failed to encourage the development of aquaculture and entrepreneurship (Botes, Thompson and Louw, 2006).

In a survey carried out in 2000 (before mandatory EIA statutes) of perceptions among mariculture operators, regulation (in the context of operational constraints) is rated predominantly as "very difficult" (Sauer *et al.*, 2003). A more recent survey carried out among fresh/marine producers asked about barriers to entry to the sector, the top ranked issue was that of "environmental regulatory requirements" (Botes, Thompson and Louw, 2006). Interestingly, in both these surveys the idea of a "one stop shop" is not seen as a priority "magic" solution, but rather producers wish for better bureaucratic performance as a solution to time consuming permit application processes (better administration, better communication). The need for regulation and the requirement for the different departments to be involved seem to be accepted.

The task facing a prospective aquaculture producer to obtain all the necessary approvals is illustrated in Figure 1, which is a flow chart combining the various sectoral requirements that are now part of the "legal environment". Environmental authorization

[8] The ICB/CBEAPSA: Interim Certification Board / Certification Board of Environmental Assessment Practitioners in South Africa.

[9] SACNASP: The South African Council for Natural Scientific Professions
SAIEES: The Southern African Institute for Ecologists and Environmental Scientists

BOX 5

Guidelines produced by state institutions for EIA

Guidelines for aquaculture EIA

- Guideline to the authorization requirements for aquaculture in the Western Cape (DEA&DP, 2006c);
- Draft guidelines for fin fish farming, marine aquaculture experiments and pilot projects in SA (DEAT, 2006a);
- Draft guidelines for marine ranching in South Africa (DEAT, 2006b);
- Guideline for authorizing the use of water for aquaculture (DWAF, 2007).

Guidelines for EIA

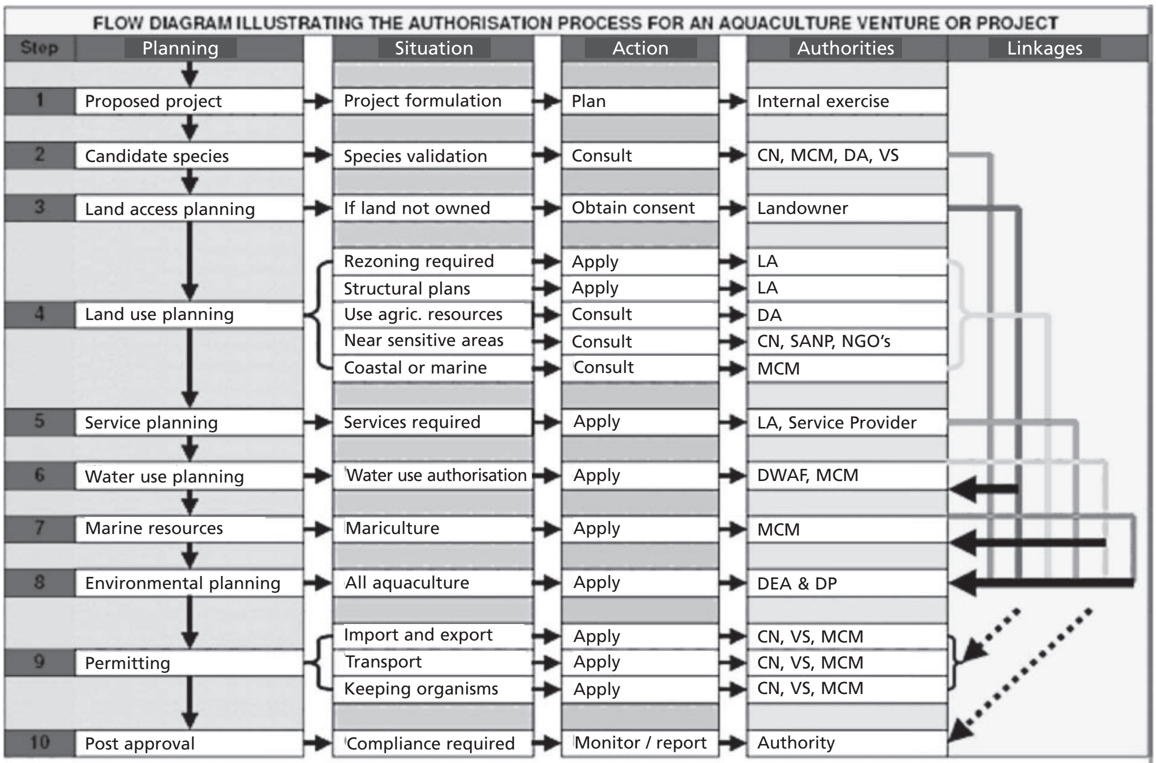
- Guideline 3: general guide to the environmental impact assessment regulations, 2005 (DEAT, 2006d);
- Guidelines on the interpretation of the listed activities (DEA&DP, 2006f);
- Guideline on public participation (DEA&DP, 2006b);
- Guideline on exemption applications (DEA&DP, 2006e);
- Guideline on appeals (DEA&DP, 2006d);
- Guideline on alternatives (DEA&DP, 2006a);

Other EIA guidelines produced by the Province of the Western Cape (DEA&DP, 2006c):

- Guideline for determining the scope of specialist involvement in EIA processes;
- Guideline for the review of specialist input into the EIA process;
- Guideline for involving biodiversity specialists in EIA processes;
- Guideline for involving heritage specialists in EIA processes;
- Guideline for involving visual and aesthetic specialists in EIA processes;
- Guideline for involving economists in EIA processes;
- Guideline for involving hydro-geologists in EIA processes;
- Guideline for environmental management plans.

FIGURE 1

Flow diagram for authorization of aquaculture (adapted from DEA&DP, 2006c)



CN: CapeNAture. MCM: Marine & Coastal Management. DA: Dept. of Agric. VS: Veterinary Services of Dept. of Agric. LA: Local Authority. SANP: SA National PArks. NGO: Non-Government Organization. DWAF: Dept. of Water Affairs and Forestry. DEA&DP: Dept of Environmental Affairs and Development Planning (via Basic Assessment or full EIA) is just one part of this (step 8). However it could be a major part given the need to combine information from the other steps into the EA study (e.g. planning, species choice, land use, water use, natural resource impacts and economic implications). With the cooperation of the different sectors involved the EA might provide a vehicle for the integration of permitting processes and so reduce the number of separate approaches that a producer has to make.

This fragmentation of the regulations is a major challenge for investors, and has highlighted critical shortfalls in the following service delivery areas:

(i) Management - the capacity to provide an effective service in each of these departments at national and provincial levels in terms of the human resources and quality of expertise.

(ii) Compliance - the capacity to promote cooperation in enforcement of the principle regulatory criteria such as monitoring and evaluation, inspection services and standards.

Aquaculture development zones

Area-wide planning and zoning is being seriously considered, and could facilitate investment by minimizing conflict with other users and more importantly by removing some of the risk and uncertainty from EA (AAPD, 2006). This would offer "ready to invest" sites zoned for aquaculture, preferably with the support of all the involved institutions cited above. These zones would be identified as suitable and secured for aquaculture use and where appropriate would indicate the suitability of cultured species. This would have the added advantage of clustering aquaculture producers in a concentrated geographical area, where they would be able to "cooperate towards common goals, and establish close linkages and working alliances to improve their collective competitiveness". Designing and implementing an aquaculture zoning policy, would require EA to be carried out on a local or regional basis, either in the form of an EIA or as an SEA which would also look at alternative zonal uses.

As can be seen from the review of legislation above, the various institutional involvements and the large amount of guiding information that is available to the prospective aquaculture investors, the regulatory situation is not simple or straightforward. These regulations are very new, very comprehensive and obviously a lot of consideration and effort has been invested in their conception. The efficacy of this framework will have to be assessed over the next few years.

THE UNITED REPUBLIC OF TANZANIA

Brief background

Aquaculture has quite a long history in the United Republic of Tanzania, dating back to the colonial period although it did not develop into a major productive activity. In the past decade there has been greatly increased interest and accelerating production.

Extensive and semi-intensive fish farming in earth ponds in rural areas is the most widespread category of aquaculture, although recent advances in extensive mariculture of seaweeds for export have increased total national production. Efforts to introduce intensive culture of shrimp in the 1990s greatly raised the profile of aquaculture among the public and investors and although these early efforts met with opposition, there are now new investors planning to increase shrimp/prawn production. At present, rural aquaculture accounts for about 1 100 tonnes and seaweeds 1 500 tonnes, with trout and shrimp less than 100 tonnes (FAO, 2006-2008. NASO United Republic of Tanzania; FAO, 2007).

The United Republic of Tanzania has exceptional wildlife resources, as well as a rich unspoilt coastline. The country has created dynamic institutions to manage these resources not least because of their importance for tourism, an important revenue earning sector, and as a result the protection of the natural environment seems to have been on the public agenda for some time.

Of note is the relatively long established legal framework explicitly directed at management of the environment. The 1983 National Environment Management Act 19/1983 is one of the oldest statutes of this kind on the continent. This law created the National Environment Management Council (NEMC) and pre-dates the widespread introduction of EIA (Box 6). During the past 10–15 years the United Republic of Tanzania has experienced a number of contentious environmental situations which became very visible to the public and to the government authorities. Two cases are particularly relevant to the aquaculture and fisheries sector and have also gained a considerable degree of international notoriety. These first-hand experiences of major impact on the national environment have contributed to shaping attitude of institutions to the control of these aspects of development, and helped create the momentum for the introduction of a new set of comprehensive legislation designed to improve environmental management.

These two examples of environmental impact that relate to aquaculture are set out in some detail in Box 7 and Box 8. They provide important examples of the real environmental risks that could face the continent and have been used as arguments in the justification for the modern environmental laws even in countries fortunate not to have experienced such problems themselves. The first of these incidents is the impact of the introduction of an alien species of fish, the Nile perch *(Lates niloticus)* into Lake Victoria. Although it was done for fisheries reasons rather than aquaculture in this case, it illustrates the high degree of uncertainty associated with any species introduction as seen in the spectacular changes to the indigenous fish populations, the fishery and the local economy, as well as other far reaching social effects.

The second example is the proposal for the large-scale development of shrimp culture in 19 000 hectares of mangrove forest in the Rufiji delta. Although it was officially supported this proposal underwent two environmental assessments and was eventually blocked by popular opposition for various reasons, the most important being fear of the impact of the project on the wider natural and social environment (SAIEA, 2003).

BOX 6

Duties of the National Environment Management Council under Law 19/1983 now replaced by Law 4/2004

(a) to consider means and initiate steps for the protection of the environment and for preventing, controlling, abating or mitigating pollution;

(b) to carry out investigations into the problems of environmental management,

(c) to obtain the advice of persons having special knowledge, experience or responsibility in regards to environmental management;

(d) to keep under review the progress made in the pursuance attainment of the objects and purposes of the Act and to publish reports and provide information for the purpose of enhancing public awareness of such progress and of the problems and remedies that exist in relation to the management of the environment;

(e) to promote, encourage, coordinate, and carry out short-term and long-term planning and projects in environmental management and protection together with or separate from other public bodies and other organs; and

(f) generally, to administer and give effect to the provisions of this Act and to carry out other functions as may be prescribed by the Council.

BOX 7

Impact from the introduction of alien species: case of Lake Victoria

The story of the introduction of the Nile perch (*Lates niloticus*) into Lake Victoria is probably globally and regionally one of the best known incidents of environmental "impact' relevant to the debate around the introduction of alien species, for aquaculture or any other reason.

Introduced into Ugandan waters for fisheries reasons in the late 1950s and early 1960s this top predator has spread throughout Lake Victoria, which extends into three national territories – the United Republic of Tanzania, Uganda and Kenya (two other countries, Rwanda and Burundi, are in the lake's catchment area). Over the following five decades Nile perch has been at the centre of spectacular and controversial changes in the "environment' of the lake, of the lakeshore communities and of the wider national economies.

The introduction was of course not accompanied by an EIA or indeed any in-depth assessment of the risks, although there was "for and against' discussion mostly among technicians. The impacts of the introduction have been many and varied. Those considered "beneficial' include its contribution to the growth of the lake fishery from its 1950s level of about 100 000 tonnes to an estimated 1 000 000 tonnes in 2006 (LVFO, 2007), of which *Lates* contributed about 250 000 tonnes; *Lates* is bought by an important processing industry around the lake supplying export markets in Japan, Europe and the USA. "Negative impacts' include reduced biodiversity as the new predator decimated indigenous cichlids, driving some species to extinction, as well as impacts outside the lake such as increased demand for wood for smoking Nile perch leading to deforestation, population movements and even suggestions of contributing to the spread of HIV/AIDS. These are all issues that might be included in environmental risk assessment today. Although this was a deliberate introduction to found a fishery, the scenario is not greatly different from the consequences that might occur as the result of an introduced alien species escaping from aquaculture installations into the surrounding environment.

One not unexpected consequence of the success of Nile perch has been the population fluctuation of the fish fauna over time as the system became quite unstable. Even today experts are not in agreement over whether the lake is approaching stability or whether there will be further major fluctuations of the Nile perch or other species. The important lesson here is that it is difficult to predict with any certainty at all. How an EIA could satisfactorily resolve this uncertainty in relation to a new introduction is not evident.

All three riparian countries have now made EIAs mandatory before the introduction of an alien species into native ecosystems. This effectively applies to any such introductions for aquaculture, as any intentions to prevent escape from installations, however well planned, are likely to be utopian.

Katima (2000) suggests the Rufiji case indicates that to be effective the EIA regime will depend among other things on the following factors which were not in place in the United Republic of Tanzania (and probably not in most developing countries) leading to frustration on the part of environmental impact assessors, governmental advisors and the public at large:

- the government's political will;
- effective environmental legislation;
- institutional support;
- proper development objectives;
- trained personnel.

The debate surrounding these direct encounters with real environmental problems has contributed to a legislative momentum to address issues of impact of development following the publication of the National Environment Policy in 1997. The United

BOX 8

The role of EIA in the proposals for shrimp culture in Rufiji delta, The United Republic of Tanzania

The Rufiji delta on the Indian Ocean coast is the largest of a number of mangrove forest sites in the United Republic of Tanzania, covering 53 000 ha (reputedly the nursery grounds for up 80 percent of the United Republic of Tanzania's shrimp). Shrimp farming had been suggested since the 1980s and in 1995 a company put forward a proposal to build a very large shrimp farm of 6 000 ha on 10 000 ha of sites in the delta, which would include a feed mill, processing facilities and hatchery, as well as production ponds. The farm was export oriented and projected to produce annual foreign exchange earnings of 300–500 million US$, a persuasive argument in seeking government support. At the time the United Republic of Tanzania did not have formal EIA regulations, but the company conducted an EIA in 1996 using qualified external consultants. Once the EIA was completed, and its content made public, considerable opposition and controversy built up around the proposal, drawing from a number of issues – land tenure, mangrove deforestation, fisheries disruption and population displacement . While some of this opposition was informed by international NGOs aware of poor outcomes of shrimp culture in mangrove areas elsewhere, significant opposition came from affected populations in the Delta supported by local environmental NGOs (Lissu, 1999).

As a result the company was required to submit a more thorough EIA, which was completed in 1997. The government asked the National Environmental Management Council to coordinate an exhaustive review of the EIA report, which involved other ministries and consultants. This review of the EIA advised the government not to approve the project for a number of reasons, including the environmental impact on sensitive habitat, and social and economic impact on the existing population of the delta. The review also recommended that better legal frameworks were necessary before such a project could be considered, and that the delta should be subject to a land use master plan to help resolve conflicts. Despite this conclusion based on the review of the EIA, and submissions of other national institutions, the government went ahead and approved the project nevertheless. This created a very public debate in the media, and in 1998 the residents of the Rufiji delta filed suit in the Tanzanian High Court and eventually won an injunction to stop the implementation of the project. A number of observations can be made from this affair, and some important actions have resulted from it.

A significant issue is that of public participation and public information (Hambrey *et al.*, 1999). There was only superficial consultation in the early stages and once the public had more information the whole situation quickly changed. Clearly it would have been preferable if the populations who were going to be significantly affected had been involved early in the EIA process, when there may have been opportunities to elaborate strategies to get around some of the difficulties. One result has been that the delta population has gained a voice in the management of their own environment. At the same time throughout the United Republic of Tanzania there is now greater awareness of the issues of environment, EIA and the potential for public participation in environmental decisions (Nshala, 2001).

A good legal framework is required if the use of EIA is going to play an effective role in such major projects as this. Without it the decision-making process can be chaotic, especially if there is no provision for the qualified authority to take a binding decision and there is no formal appeal process. In this case, despite what turned out to be decisive objections, there was a political willingness to approve the project which is not surprising given the financial stakes involved and differing perceptions of national interest. It also highlights how oversight capacity is important to the implementation of environmental law, especially EIA. EIAs are carried out by the project promoters and it is not unexpected if they tend to favour the investors viewpoint, especially in the case of new unfamiliar activities such as aquaculture. In this case the EIA was done on the initiative of the promoter, partly as a justification of their initial plans and at least partly as a defensive exercise, as expressed by the project manager at the time: "to defend us from attacks from the environmental community" (Rosenberry, 2007).

Republic of Tanzania has now completed a comprehensive update of the overall legal setting, which effectively puts environmental concerns at the centre of any future development of aquaculture. This includes a new framework law (including details of obligations for public participation and clear decision making responsibilities) and regulations for EIA, backed up by guidelines for promoters and stakeholders.

Legal framework for environmental assessment

The 1983 Act does not mention EIA, which is a specific legally required process introduced in the 2004 Act. In between these two Acts of 1983 and 2004, the use of EIA was undertaken for some major projects involving external investment, partly motivated by the requirement of institutional investors themselves.

First in the National Environmental Action Plan of 1994, and then formally in the National Environment Policy (NEP) of 1997, EIA was given official backing as a key tool in national planning and decision-making in order to avoid unnecessary damage to the environment. The Marine Parks and Reserve Act, No 27 of 1994 also imposes tight restrictions on installations within some of the sensitive habitats that might attract investors in shrimp farming and other mariculture. It was at this stage of legislative evolution that EIA was used during the contentious proposals for shrimp farm development in the Rufiji Delta.

The 1983 Act has now been replaced by the Environmental Management Act 4/2004 (United Republic of Tanzania, 2004b), which is a very comprehensive law providing for the detailed management of all aspects of the interaction of human activity with the environment. As well as the usual articles detailing management obligations such as EIA or pollution control, this Act enshrines in very clear language a number of principles behind the articles of the law, for example "the precautionary principle" and the "polluter pays principle". The result is a comprehensive and potentially powerful legal tool bringing environmental concerns into most areas of national development. The 2004 Act includes provision for SEA which could be the basis for assessing planned initiatives for land use along the coast, including growth of aquaculture. In the case of aquaculture, the 2004 Act should be looked at in combination with another updated law, the Fisheries Act of 2003 (United Republic of Tanzania, 2003). This conforms to the aims of the National Environment Policy and the Environmental Management Act 2004, and enshrines policy positions on ecosystems, species diversity and EIA obligations, among others. As far as the Fisheries Act is concerned it appears that the articles are more concerned with controlling the impact of aquaculture on others, than they are at protecting the aquaculture sector's interests in the environment from negative impacts caused by other activities. This was perhaps a missed opportunity to demonstrate to stakeholders and investors a potential benefit to aquaculture from having environmental regulation.

Once the framework law of 2004 was passed the government was able to follow this up with the EIA and Audit Regulations of 2005 (United Republic of Tanzania, 2005). This body of regulation applies principally to the mainland and some of the islands. Zanzibar, which retains a degree of legal autonomy within the republic, has a distinct set of laws regulating the environment on the island (Majamba, 2005).

Following the enactment of the National Environmental Policy for Zanzibar in 1992 which already included the basis for EIA, the Environmental Management for Sustainable Development Act, 1996 introduced detailed rules for conducting environmental impact assessment process nine years before the mainland. Actual compliance has not been consistent (EAAIA, 2007) and EIA has not been used for any major aquaculture projects. One experimental fish farming project at Makoba included an EIA for the change in the land use from solar salt mining to fish and shellfish mariculture (Mmochi and Bhai, 2005). However Zanzibar will be attractive to investors in mariculture, and this activity would be included in the EIA process through the article:

"no licensing institution shall issue a license, permit, certificate, or other forms of approval for an activity which is likely to have a significant impact on the environment unless an EIA certificate has been issued for the activity."

The Zanzibar regulations provide for some interesting innovations for dispute resolution and enforcement of environmental regulations. A mechanism is provided for out-of-court settlement for resolving environmental disputes. Special environmental mediators can be officially appointed; they must be persons trained in alternative dispute resolution, have experience in environmental matters and be acceptable to the parties in dispute. According to Majamba (2005) this is likely to need far less resources than the setting up of a full environmental tribunal, something which is provided for in other national frameworks but which often do not operate properly for lack of resources. Should a dispute come to court, there is also a provision for the designation of a state attorney responsible for representing the interests of the public, as opposed to representing the state's interests as would be the usual situation.

EIA and aquaculture

The Tanzanian EIA regulations make the basic stipulation that if any *"project is likely to have significant adverse environmental impacts"* then it must undertake the full EIA process, while a lighter process called "Preliminary Environmental Assessment" (PEA) is required if the *"project is likely to have some significant adverse environmental impacts but that the magnitude of the impacts are not well-known"*. These regulations go on to specify in some detail certain activities that are liable to these two levels of environmental assessment. Aquaculture is specifically mentioned as follows:

Liable to EIA (first schedule):

4. Fisheries
   - artificial fisheries (aquaculture for fish, algae, crustaceans shrimps, lobster or crabs);
   - introduction of new species in waterbodies;
   - large scale fish farming including prawn farming;
   - introduction of genetically modified fish species and other aquatic species.

Small-scale activities that require registration and a PEA (may or may not require EIA):

- fish culture;
- seaweed farming.

There are, however, several other specified categories that overlap with aquaculture and make it even more likely that an EIA would be required for a large project:

- water resources development projects (dams, water supply, flood control, irrigation, drainage);
- intensive livestock rearing units;
- industrial fish processing and storage;
- canalization of water courses;
- diversion of normal flow of water.

The Fisheries Act 2003 aims to ensure "aquaculture development is ecologically sustainable and allows rational use of the resources shared between aquaculture and other activities" and specifically reinforces the requirement for EA (United Republic of Tanzania, 2003).

In the particular case of introduction and translocation of species, the regulations make a particularly strong statement by listing this issue under a total of *eight* headings as being liable to EIA, apparently indicating a clear reluctance to countenance such initiatives (alien species four headings, new breeds/strains two headings and GMO two headings).

Concurrently with the development of these laws, authorities have also produced a number of detailed guidelines for proposals that might be subject to EIA (United Republic of Tanzania, 2004a). Although there are none yet published specifically for EIA and aquaculture, similar issues for aquaculture/mariculture are dealt with in some detail in guidelines for sectoral development published before the EIA regulations were finalized (Tanzania Coastal Management Partnership, 2001).

The fact that EIA has increasingly been employed for projects and programmes is a sign that environmental awareness has been improving amongst decision-makers, donors and the general public, and progress is being made in mainstreaming environmental concerns into decision-making (Assey *et al.*, 2007). Still, when it comes to effective public participation into the process there is much progress to be made to increase understanding among the general public and government decision makers (EAAIA, 2007).

Public participation, an issue that came to the fore in the Rufiji case, is an important part of the EIA regulations and it states that the "proponent shall in consultation with the Council, seek the views of any person who is or is likely to be affected by the project". He is expected to do this by publicizing the project proposal, holding meetings with the aid of an approved facilitator and recording the comments of the public to be attached to the EIS. Any person aggrieved by a decision approving or disapproving an EIA has the right to appeal to the Environmental Appeals Tribunal.

UGANDA

Background

Fish has always had a prominent position in Uganda, providing employment principally in the lake fisheries and supplying markets where fish is in demand as an important part of Ugandan food supply. Aquaculture has quite a long history in the country having been introduced during the 1950s, but it has remained a minor activity until renewed interest over the past years (FAO, 2006-2008. NASO Uganda). Currently there a number of new initiatives being implemented and further growth can be anticipated.

According to the Department of Fisheries there are two key species cultured in Uganda contributing over 90 percent of the total aquaculture production in the country. African catfish (*Clarias*) has overtaken Nile tilapia (*O. niloticus*) and is now the most common culture species in the country. However, with the efforts of the government to improve the infrastructure for export of fish products to premium markets and investors" interest in tapping this market, it is possible that Nile tilapia will overtake African catfish in a few years, given its international market position.

Traditionally, most aquaculture has been carried out using extensive and semi-intensive methods in small rural ponds. Today there are an estimated 20 000 ponds in Uganda, with an average size of 500 m^2 producing between 1 500 kg/ha/year and 15 000 kg/ha/year. Recently, some of these farmers have been encouraged to improve their methods and there are now about 200 classified as "emerging commercial farmers" producing up to 15 000 kg/ha/year by incorporating improvements in the quality of fish seed and feed. In addition there is now a prospect of significant growth in production with a number of proposals for large farms from industrial/commercial investors attracted by the favourable conditions/resources and the established fish-exporting infrastructure. Overall, this confirms a trend towards greater intensification of aquaculture in Uganda, and if the methods traditionally used have caused no environmental concerns, it must be expected that this will change and that new intensive methods, such as farming in cages in Lake Victoria, will in future raise significant questions.

The fisheries sector provides the backdrop to one of Uganda's highest profile debates over the environmental issues, following the introduction of Nile perch into Lake Victoria (see Box 5). Certainly, this debate has contributed to heightening Uganda's awareness of environmental issues and is a warning of the potential (for both good and bad) of causing major disruption as the result of an (apparently) minor development decision. Media, environmental NGOs, national and local politicians have a much greater engagement with environmental issues than in most countries in Africa, as is demonstrated by popular debate over issues such as converting forest land for sugar and oil palm production and use of plastic packaging that are currently going on. The heightened concerns of civil society are reflected in the introduction of a comprehensive new legal framework and the institutional initiatives of the past ten years.

Legal framework for environmental assessment

The current framework for environmental management came into existence with the Environmental Management Act of 1995, which at the same time created the National Environmental Management Authority (NEMA) an institution with responsibility for coordinating environmental interventions in Uganda. Subsequent statutes have been passed to complete the framework with the necessary tools, including the use of EIA:

- The Environmental Management Act (Uganda, 1995/2000);
- The Environmental Impact Assessment Regulations (Uganda, 1998);
- The National Environment (Conduct and Certification of Environment Practitioners) Regulations 2003;
- The Aquaculture Rules 2003.

Other policies and guidelines have been issued as part of the overall management framework in Uganda:

- Environmental Impact Assessment Public Hearings (Uganda, 1999);
- The National Biodiversity Strategy and Action Plan (NEMA, 2002).

Also, there are guidelines concerning "Environmental Economics", "Environment Audits", "Environmental Management at Local Government Level", "Environmental Indicators for Uganda" and an "Environmental Audit Manual for the fish processing sector in Uganda". Guidelines for aquaculture are under study.

Liability of aquaculture to EIA

Projects are initially screened into three major categories to determine their liability to the process, on the basis of a project brief:

a. Small-scale projects whose potential adverse environmental impacts can easily be identified and for which mitigation measures can readily be prescribed; these would normally be approved on the basis of the identified mitigation measures without the need for a detailed environmental impact study requiring field investigations.
b. Projects for which there is some level of uncertainty on the nature and level of impacts, thus requiring a more in-depth environmental impact review, which provides the information to determine whether or not a full EIA is required.
c. Projects which clearly will have significant impacts whose mitigation measures cannot readily be prescribed unless a detailed environmental impact study of the project and its possible alternatives is conducted.

In the original text of the Act, there is no mention of how exactly aquaculture projects should be assessed for their liability to submit an EIA before they start. It is assumed that subsistence aquaculture would not require any approvals of this kind. This is partially clarified in the aquaculture rules, which define intensive and "large-scale semi-intensive" farms as being required to seek environmental approval from NEMA. The triggers for this decision were originally set at 4 000 m^2 and/or three fish/m^2, but these criteria are under review. EIA is however mandatory for “storage dams, barrages and weirs” as well as “introduction of new crops and animals” – both likely scenarios for some aquaculture proposals.

If the project brief is not considered adequate, a full environmental impact study is required, following which an EIS is submitted to NEMA for review. If the final judgement of the review is favourable, a Certificate of Approval is issued along with the recommendations for subsequent monitoring.

Challenge of developing the human resources for EA

Authorities in Uganda have been unusually proactive in the steps taken to address the problems of improving the institutional capacity for environmental management and of acquiring the human resources necessary to implement the environmental regulations. Internal training is carried out by NEMA alongside training for personnel involved in environmental management in partner institutions such as local councils, government ministries and departments and selected NGOs.

The Makerere University Institute of Environment and Natural Resources offers post-graduate diploma courses in EIA and environmental information management (EIM) targeted at environmental practitioners and public sector professionals. Nevertheless there is still a need to increase the capacity of staff available to institutions and the consultancy sector and to improve the quality of EIAs being carried out (Ecaat, 2004). Considerable progress has been made in recruiting district environment officers and providing subsequent training on EIA and this has helped local government capacity to contribute to EIA reviews (IUCN *et al.*, 2007).

The private sector has also improved its organization. The increase in the demand for EIA professionals initially brought with it a problem of inexperienced practitioners, which prompted NEMA to enact new regulations[10] and create a database of Registered and Certified Environmental Practitioners (NEMA, 2008) which is maintained and published for the benefit of developers who are obliged to carry out EIAs.

Environmental practitioners themselves have created the Ugandan Association for Impact Assessment (UAIA) founded in 2001 to represent their profession. It is also potentially significant that producers are getting more organised, and have formed the Uganda Commercial Fish Farmers Association, which as a professional organization could be used to improve farmers” engagement with the EIA process.

Public participation in the EIA process

Environmental awareness in Uganda, both in government and civil society, is as well developed as anywhere in Africa and has been witnessed in recent years in the lively debates around a variety of environmental issues. EIA is quite a familiar term and can be a “hot” subject in the media. Although the Ugandan EIA system has provided the opportunity for public participation, there remains the challenge of ensuring that the public, beyond some NGOs and active individuals, take full advantage of the opportunity that is afforded to them (Ecaat, 2004).

The regulations (Uganda, 1998) make it necessary during an EIA for the public to be systematically associated with the decision-making process at three main stages:

1. In preparing the environmental impact study, the developer must:
    - publicize the proposal in the media;
    - within 14 days hold public meetings with affected communities;
    - hold meetings at convenient times and places in agreement with local councils.
2. The NEMA should invite comments on the EIS:

[10] National Environment (Conduct and Certification of Environmental Practitioners) Regulations of 2003

  - by publishing an invitation for written comments from the public (the invitation should make clear the nature and location of the project, the anticipated positive and negative impacts and possible mitigation measures);
  - by requesting comments directly from individuals and institutions most likely to be affected by the proposal.
3. The NEMA should call for a public hearing where it is required in the interests of a fair and just decision, or necessary for the protection of the environment and promotion of good governance.

Effectiveness

The willingness to legislate and impose a procedure like EIA brings with it the risk of making entry to the aquaculture sector unnecessarily difficult. Observers have noted that the number of different permits that can be required by a fish farmer is becoming excessive (DTIS, 2006a). The 2003 aquaculture rules attempt to establish the regulatory framework for aquaculture. The rules impose permits for different aquaculture related activities: semi-intensive and intensive aquaculture, fry production and marketing and for domestic movement of cultured fish. In some respects, the existing aquaculture rules are too onerous; in others they do not address key requirements. The rules also restrict import of live fish, use of genetically modified fish and require certification of aquaculture inputs including feeds, fertilisers and veterinary compounds (DTIS, 2006b). The approval and permit requirements of the rules would be on top of an EIA, although an EIA alone might be sufficient as the latter would anyway have to verify that a farm is operating correctly under national statutes and rules.

NEMA as an independent agency has had difficulties coordinating environmental interventions in a climate of intersectoral "competition", and has been perceived as intervening on an ad hoc basis motivated by political agenda. In response NEMA has experimented with environmental units within the key sectoral institutions, in a programme for creating environmental liaison units (ELUs) (PADELIA, 2002). These units have had mixed success. Also with the objective of decentralising the environmental function, NEMA have trained district environmental officers, who are employed by local government, and are responsible for overseeing local environmental activities including EIA.

With respect to sustainable aquaculture development, it has been suggested that the government should undertake a GIS based exercise for aquaculture, mapping environmental and natural resource parameters among other things, and use the data collected to designate "aquaculture development zones" in areas that can meet suitable environmental criteria for aquaculture (climate, water supply characteristics, soil conditions, production technology – both ponds and cages), as provided for in the provisional Fisheries Sector Strategy Plan. This could be seen as an opportunity to apply the principles of SEA to the promotion of sustainable aquaculture. Aquaculture development zones would become the focus of rural infrastructure development (roads, electricity, supply canals), and could be subject to generic environmental impact assessments, thus facilitating small and medium scale investments in suitable areas (DTIS, 2006a).

Options for greater efficacy of EIA when used for aquaculture in Africa?

Although the quantitative lack of EIA studies in aquaculture in Africa is due in large part to the low level of large scale aquaculture operations on the continent, it is widely expected that the coming decades will see greatly accelerated growth. This growth will bring with it increased risk of major negative environmental impact, and the national provisions for EIA will become more and more relevant to both farmers and government. There is an opportunity in the next few years to sharpen the EIA process to make it cost effective and well adapted to local environments and capacities, and at the same time guide the whole sector towards the best possible practice relative to the environment.

The continent is large and varied and there will be few "one size fits all" solutions to the problems of EIA use in aquaculture. This variety can be seen at many different levels, most of them needing their own adapted solutions, and includes differences:

- between major regions, watersheds, climate zones;
- between countries at different stages of economic or political development;
- between landlocked and coastal states;
- between water-blessed and arid areas.

Finding these solutions is a "work in progress", and it can be seen in those countries with the greatest commitment to EIA that regulations are evolving with a distinct local flavour. From the starting point of a basic "imported" concept, and generalized framework environmental laws, these countries have developed the process through detailed statutes, regulations and guidelines which have been added to the basic framework.

HAS EIA BEEN EFFECTIVE SO FAR?

It is a fact that use of EIA in aquaculture has been limited to a small number of projects in just a few countries in Africa, and so it is not possible to come to sweeping conclusions about the effectiveness of the process in achieving its overall objectives. Beyond aquaculture, EA is evolving rapidly with changes in attitude and elaboration of policies and legal frameworks. Reviews of the general effectiveness of EIA in Africa however have raised a number of points (IUCN *et al.*, 2007):

- institutional and regulatory frameworks established in many countries;
- number of EIA applications increasing;
- increased inter-agency collaboration;
- administration/regulation remains too centralised;
- regional professional networks increasingly being formed;
- quality and review systems hampered by inadequate capacity;
- public participation increasing, but inadequate;
- influence of EIA on decisions still not significant;
- some countries conducting SEAs;
- institutionalization still slow;
- political will and support still to materialize in many countries.

Nevertheless the experiences so far do give some insight not only into the quality of the EIA exercise itself, but also the effect the introduction of the EIA regulations has had on the sector in general.

Probably the most noticeable contribution has been to focus the minds of farmers, investors, fisheries staff and the general public on the important issues of environmental quality and management. Of course it is not EIA on its own that has improved this awareness of the issues, but the combination of many elements – government policy, creation of new laws and institutions, general public awareness, media messages, NGOs and public campaigns. EIA, as a legal obligation, is the innovation that requires action (and expense) and gives it a higher profile.

Changing perceptions about EIA

Undoubtedly the first reaction of farmers to the introduction of EA will often be negative, in reaction to what will be perceived as a supplementary and unnecessary additional piece of "interference". As it is a legal obligation, this reaction is not surprising, especially when the local implementation of the process emphasizes aspects of control and interference by public authorities.

The challenge is to emphasize the positive contribution that a careful approach to environmental interactions can make to aquaculture, to the benefit of all concerned and in particular to the farmers, producers and investors involved. EIA and environmental monitoring need to be promoted as a tool to achieve better standards of practice, with medium and long-term benefits for sustainability and business profitability as well as wider aspects of national well-being. There should be little to fear in the process.

Pioneers and EIA

Most commercial aquaculture investors at the moment are "pioneers" in the African context and this amplifies to some extent the complexity of EIA. For the "pioneers" there are few if any precedents which can provide guidance, which may in itself be discouraging at least to any investors averse to risk. There is a paucity of easily accessible technical and environmental knowledge, which makes the studies more challenging and probably more costly as the studies carried out will effectively be carrying out original research.

ARE EIA LAWS AND LEGAL FRAMEWORKS ADAPTED TO AQUACULTURE/ AFRICA?

It has been suggested above that the environmental legal frameworks introduced by African countries have to some extent been modelled on statutes and procedures from outside the region. This raises the question on the rate of adaptation of these models to the situation in different countries in Africa.

Extent of legislation, EIA obligations

Box 2 and Table 2 above give a summary of the statistics concerning the legislation surrounding EIA in 54 countries and territories in Africa.

Almost all African countries, anglophone, francophone and lusophone – now have framework environment law. They are quite varied in the details, although for historical reasons there are clear resemblances in the laws within each language group. The countries still without modern environmental laws are mostly those undergoing, or coming out of, periods of extreme political upheaval.

Three quarters of all countries have published specific EIA regulations. In all of these countries aquaculture could be liable to assessment and an investor should be aware of this possibility and include it in their plans. Half of all these EIA regulations make explicit mention of aquaculture, which must therefore satisfy at least a preliminary review that determines whether or not there is potential for significant impact. Considering that many aquaculture initiatives in Africa are at a small-scale, the threshold at which EIA becomes mandatory for aquaculture is significant. In fact this threshold is extremely variable. In some countries it applies in theory to all aquaculture projects irrespective of size (examples: Ghana, Liberia, Namibia, Seychelles), but in other cases EIA is only mandatory above a certain size (examples: Mozambique if area over 5 ha; Zambia if production over 100 tonnes/year; Malawi if water capacity over 100 m^3). In one case, Algeria, aquaculture is specifically excluded entirely from the EIA regulations (in favour of other regulations).

One very important component of many of the EIA regulations is the definition of a two tier environmental assessment, whereby some activities are exempted from conducting a full EIA study, but are submitted to a lighter less comprehensive process instead. This has various titles: e.g. basic assessment, preliminary assessment, project brief, environmental impact notice. In some countries aquaculture is generally only included in the lower tier (example: South Africa – basic assessment for aquaculture, and only if production over 10 tonnes/year). In other examples, two thresholds are defined for aquaculture (example: Togo – "simplified EIA "under 300 ha, and "in-depth EIA" over 300 ha, or Madagascar – "PREE" for semi-intensive aquaculture, "EIA" for intensive aquaculture).

There are three other important concerns that show a great deal of variation between country regulations:

- obligations for the public to be informed, consulted or given the opportunity to participate;
- cost recovery by the national authority in the form of fees;
- access to the information provided in EIAs.

From all this detailed information it is clear that aquaculture is now subject to extensive obligations under EIA regulations right across the continent. To some extent this is a situation that the sector itself has yet to fully take on board, and aquaculture departments will need to adapt to it as the national environmental authorities gain experience and move to more effective compliance.

Adapting EIA processes to the small-scale farmer

The language of the statutes and in many cases the detailed obligations involved in acquiring the various "environmental" approvals would seem to be particularly daunting for a small-scale farmer or business. As indicated above and in Table 2, some legislation specifically excludes small installations, while others theoretically include all sizes within the scope of EIA. The tendency of some frameworks to insist on "polluter pays" principles could also be a potential obstacle for poorer categories of farmer, particularly if environmental advice is not made available as a public service.

Three reasons can be advanced for including the small-scale farmer to some degree in environmental assessment processes. Firstly, there is always a potential for an aggregation of small farmers to collectively create unexpected environmental impact. Secondly, this category of farmer would benefit from some formal protection from negative impacts on their resources as a result of other external activities. Thirdly, environmental issues are often a key part of the message working towards "best aquaculture practice" (for example in sustaining good water quality). Some support to small-scale farmers can be provided as part of institutional outreach activities, possibly in the form of a simple checklist approach, which informs the farmer/extension personnel of the best management options for aquaculture and draws attention to acceptable or unacceptable practices.

Multiple or overlapping legislation governing aquaculture

The legislation governing aquaculture is dispersed among a number of sectoral laws in most countries, very few countries having specific aquaculture legislation to cover all requirements. These include such sectors as fisheries, agriculture, forestry, environment, water and land to name just the principal sectors involved. This has two potential consequences to note.

Environment, a relatively "young" sector, can encounter difficulties in the efficient implementation of its EIA regulations when it is seen as a junior partner by more "senior" departments or ministries. Mainstreaming environmental concerns across public institutions, including for instance aquaculture or fisheries departments, make the regulations easier to apply consistently.

The other consequence of multiple legislation is that in order to comply with all the requirements, proponents of aquaculture have to acquire a number of permits and authorizations, each of which demands expense, time and effort. This is the case for example for farmers in South Africa and Egypt, where long established land and water management institutions retain effective control of their sectors, including interaction with aquaculture.

Single window or one-stop-shop approach

The idea of a single window approach to gaining regulatory approval for an aquaculture investment is an attractive one (Percy and Hishamunda, 2001) but not necessarily simple to achieve unless cooperation can overcome competition between relevant authorities. It is of interest however, that farmers surveyed in South Africa thought the better solution would be to improve the efficiency of the current institutions rather than attempt to create a new one-stop structure.

Dynamic approach to hard/soft law

Both the environment and aquaculture sectors in Africa are expected to evolve quickly over the coming years, so it is important that initial versions of these regulations do not become "set in stone". There should be opportunities for the aquaculture sector and the environment institutions and stakeholders to review whether current rules are really appropriate, and to revise them later in the light of mutual experiences.

Guidelines are often published to assist in understanding, interpreting and implementing the formal regulations. It is common to have general guidelines for the interpretation of the EIA regulations, which are legal texts that are not always easy to comprehend. Some countries provide sectoral guidance to aid project proponents to prepare and present the various documents that are required over the length of the assessment cycle. South Africa, in particular has produced a wide range of guidelines covering a variety of situations. Three countries – Seychelles, South Africa, Madagascar – have published specific guidance documents for aquaculture which are aimed at assisting aquaculture investors to interpret the EA laws; other countries have similar guidelines in preparation. The African Development Bank also has guidelines for aquaculture which are combined with capture fisheries, as part of the forestry guidelines (AfDB, 2003).

Guidelines, however, are not always seen as the answer, and run the risk of leading to a mechanistic and rigid approach to carrying out an EIA, when a freer more intuitive and pragmatic approach to individual projects might lead to better assessment of impact and real risk in a complex environment (Spooner, 1998).

STAGES OF A STANDARD EIA PROCESS

National regulations specify the procedures for conducting an EIA. These are expressed as a number of distinct steps generally similar to the generic outline for the EIA process (see generalized EIA process flow chart in Appendix 3 of this publication). There are many minor variations and vocabulary differences but the principles are broadly similar.

Screening

This is the stage at which applications are filtered by the environmental authority and a decision is made on whether or not a particular project is liable to carry out an EIA.

A project can also be rejected at this point as environmentally unsustainable. It is an important stage, and in the context of aquaculture there are choices to be considered over the liability of small-scale farmers, farm intensification and the risks of eventual impacts. The decisions taken can be decisive for the future of a proposal including the eventual cost to the investor, should extensive studies be required by the agency.

Half of the national regulations of the African countries studied specify some of the criteria to be used in screening aquaculture projects (see Box 2 and Table 2 above). In the other cases aquaculture would be screened as potentially an activity that requires an EIA "if the project would have significant (unspecified) impact". The specified screening criteria in a few cases makes EIA mandatory for all aquaculture, but in most cases there is a minimum threshold defined by physical size or production output. Only in one country is all aquaculture excluded from the EIA regulations. A possible difficulty with a number of the regulations is that they are worded in an inclusive way, with no clear way of dealing with the very small-scale farmer, such as those with a fish pond or small-scale seaweed culture rack. Some situations like this require that the supervising authority be able to apply pragmatic decisions, exempting low risk proposals at screening.

Some of the regulatory procedures have a feature that seems to adapt well to the situation for African aquaculture. This is a two speed assessment, with a third option of total exemption. The applications which carry the most risk (large scale, most intensive culture methods or location in a sensitive area) are liable to a full in-depth EIA. The smallest farm ponds would be exempted, while in between these are small-scale enterprises that would have to undergo a limited assessment before being given environmental approval. The aim of this option is to verify that the applicant has already made an effort in the project planning to integrate environmental concerns into the siting and methods to be used. These reduced requirements go under various names, which indicate some of the philosophical differences between them. Ghana can request a "Preliminary Environmental Report" (sometimes referred to as a PEA), which can lead to approval and the issue of an environmental permit without recourse to a full EIA (Ghana, 1999). Madagascar requires that all aquaculture projects prepare at least a PREE, which can be sufficient for approval without EIA (O.N.E., 2006b). The PREE consists of a "commitment by the project promoter to take certain measures to reduce the impact of his activity on the environment, as well as measures to eventually rehabilitate the project site" (Madagascar, 2004).

This two-speed approach can recognize that many aquaculture producers do not cause significant negative impacts, and can avoid imposing the cost and effort required by EIA where it is not essential. It will also be effective in "educating" all applicants to introduce environmental concerns into the planning phase of their projects.

Scoping

If screening identifies the need for EIA, most national procedures undertake "scoping" often with interaction between the promoter and the environmental agency, or even other stakeholders (see Box 9). The scoping process identifies the issues that are likely to be of most importance during the EIA and eliminates those that are of little concern. In this way, EIA studies are focused on the significant effects so that time and money are not wasted on unnecessary attention to minor impacts. Once the scoping is completed, terms of reference for the EIA studies are agreed upon. Public consultation is best initiated at this stage so that the concerns and priorities of the local communities are taken on board as early as possible.

EIA studies: investigations and evaluation of potential impacts identified in the terms of reference

This stage forms the heart of the EIA process and involves a detailed assessment and analysis of all the important potential impacts identified during the scoping stage. The

BOX 9

Approaches for assessing the significance of impacts

Impacts can be grouped into two categories, depending on how their significance is assessed:

1. Impacts for which there are published standard criteria, regulations or for which levels of acceptability have been determined. Few countries have published clear criteria for acceptable environmental impact (Environmental Quality Objectives - EQOs); research is urgently needed in most African situations to address this issue.
2. Impacts for which the assessment has to be based on the qualitative judgment of various stakeholders:
   (i) opinions of qualified decision makers in municipalities, or ministerial departments based on the government's national and sectoral development policies;
   (ii) opinions of specialists (e.g. environmentalists, ecologists, hydrologists, geographers, agronomists, sociologists, urban planners);
   (iii) past documented experience of similar projects;
   (iv) surveys of public opinion as to acceptability of impacts.

studies are normally the responsibility of the farmer/promoter and he may often hire specialists especially for the larger projects. In fact in some cases, such as South Africa, the regulations state that independent approved consultants must be used. The end product is an EIA report (or Environmental Impact Statement (EIS) which forms the basis for institutional review and the decisions on the final approval for the project.

Identification and prediction of the magnitude of eventual impacts needs to be undertaken against an environmental baseline, and where this baseline information does not already exist, the necessary data must be obtained as part of the EIA. It is also necessary to determine the acceptable level of impact of the new activity. For technical parameters these can be published by the national agency, for instance for water quality (e.g. Biological Oxygen Demand (BOD) in water effluent, chemical pollutant concentrations) or water consumption. These standards have yet to be determined in most African countries. As a short-term measure some environmental standards may be adopted from developed nations or even international banks, although this is not ideal (Wood, 2003), provided careful consideration is given to their suitability for application in Africa. Factors such as climate, ecology, population density and social demands are all likely to vary from country to country and region to region and will influence the level at which the thresholds are set. Gauging the acceptable levels of impact for those things that require qualitative judgement should be done at both local and national level, and requires experience and meaningful stakeholder consultation.

Given the limited experience of commercial aquaculture, many EIA studies will have to obtain original data and information. Accumulating a national database (of non-commercially sensitive) information from these studies and keeping it accessible in the public domain is essential to improving the process and to promoting aquaculture development in Africa.

Consideration of alternatives

A comprehensive EIA is required to assess the relative environmental costs and benefits in making choices between say aquaculture, and other alternative uses of resources. Equally, consideration should be given to alternative aquaculture methods and technologies to be used by the project, and/or alternative sites, with a view to identifying those which can mitigate some of the potential impact. Local community preferences will play a part in some of these decisions and as a consequence are likely to be subject to various social and political influences.

Consideration of alternatives, as well as the identification of mitigation measures, is a process that starts at the screening of the project and intensifies until the production of the environment impact report and could even be raised again after a period of environmental monitoring.

Mitigation planning

One of the key aspects of the EIA process, recognising that impacts will inevitably occur, is the identification of ways of reducing eventual negative consequences of introducing a new activity. These mitigation measures may take many forms, from changes to infrastructure design, specification of certain management measures, monitoring/ feedback programmes with the involvement of public institutions and permanent community consultation. EIA obliges the promoter to include this reflection before approval can be given. There is no reason to conclude that this will necessarily lead to higher costs, rather it should improve general sector practice.

As the aquaculture sector (both public and private elements) becomes more experienced, some of the mitigation measures initially adopted as the result of EIA studies and monitoring for some pioneering projects, will be adopted by future projects and successfully integrated early in the project cycle before the screening process. This will reduce the amount of work needed for an EIA and consequently reduce the cost of the study.

Final approval process

This stage depends on the individual arrangements of each country system, and usually there are appeals procedures associated with it. It needs to be transparent and open to public scrutiny by all stakeholders, public and private. The review has to be conducted by technically competent officers, or there will be a risk that the approval process becomes reduced to a bureaucratic rubber-stamp exercise for a fee.

Public participation in EIA process

This is a challenging facet of environmental assessment in Africa. Public participation in project decisions is not an exercise that is commonly used and government and national agencies are more accustomed to a top-down approach to decision-making. While this may be appropriate for the more technical impacts that confront a project and the environmental agency, there are many other impacts that may occur and involve others, and which may not have been considered previously before the use of EIA. Those who may be affected, generally called "stakeholders" or "the public" in the regulations, include other businesses – such as suppliers to aquaculture – upstream and downstream activities even distant from the project, local communities, other sectoral authorities responsible for health and education provision and infrastructure providers, as well as various economic factors at a national level. While there are decentralised government institutions, such as rural councils, which provide local representation, it is a fact in many parts of Africa that, regardless of their legal status, it is traditional frameworks that play a major role in many decisions for local communities, and these include key aspects for aquaculture such as land access and use, water access and rights of way. African communities are not homogeneous and have their own various ways of engaging citizens in decision-making. Finding inclusive ways of carrying out public consultation should be a priority where large scale projects are proposed (Motsamai, 2003).

Monitoring

The final phase of a full EIA is the follow-up provided by the farmer and the appropriate institutions, to ensure compliance and to detect any impacts that might arise later. In view of the early stage of development of African aquaculture, and that there is often a lack of hard data from the region, this is probably the most important phase of EIA in the short-term.

EIA as a single compliance event is of limited use unless it is combined with sustained monitoring. Normally EIA regulations require the promoter to prepare an environmental management plan (EMP) that is reviewed as part of the EIA report before project approval is given. In fact the two steps of EIA and monitoring are inseparable, and insofar as we are not often sure of the extent of future impact of aquaculture – impacts which can be long term and not immediate – monitoring is really even more important. It is the monitoring that can indicate whether or not the original decisions made during the EIA are having the expected results, and it is essential to feed back potential improvements into the screening and scoping stages as well as improving the search for mitigation solutions.

All EIA regulations appear to require the use of EMPs or something similar, although not all give any details on how monitoring should be carried out, by whom and with what frequency. Most reviews of EIA in Africa identify this stage as weakness in the system, primarily because the environmental agencies do not, or are not able to provide the necessary follow up to ensure that the EMP is being carried out, nor to appraise the results of the monitoring. Most of the monitoring activities are expected to be carried out by the producers themselves, but there are other parameters affecting the wider environment and various national interests that will need input from the environmental agency or other public sector institutions.

Essentially, this weakness in professional capacity seems to be linked to the availability of resources (CLEAA, 2007b; IUCN *et al.*, 2007), as well as to political will and commitment. Capacity within the main environmental agencies is already generally considered inadequate to administer, guide and review the basic EIA process, so there is little capacity left to carry out one of the most difficult tasks, to monitor and follow up EMPs.

However, in this situation of constraint on resources, some special priority should be given to the monitoring phase of EIA. Given that most of the aquaculture methods used presently in Africa do not present a significant risk of long-term environmental harm, more will be achieved by allowing acceptable projects to go ahead, while insisting on a comprehensive monitoring of the project's interaction with the environment. Data and measurement should be part of this, and the fisheries/environmental/private sector institutions should work together to assemble databases of relevant information with widespread access. This information is needed to inform EIA related decisions and is knowledge that will contribute to making aquaculture projects more sustainable and profitable.

ROLE OF EIA IN AQUACULTURE DEVELOPMENT IN AFRICA

Building an industry with positive engagement with environmental concerns

Control or education

EIAs could be said to have two roles – legal enforcement and education.

The legal role is quite straight forward: to ensure that development projects such as a shrimp farm, a road or a new open cast mine comply with standards that aim to minimize impacts on the environment throughout their entire "lifecycle" – i.e. during design, construction, operation, maintenance and demolition. For many of these categories of development, it is a focus on mitigation of the expected inevitable negative impacts that they will cause.

The educational role is equally important – and should really precede the enforcement role – and aims to raise the awareness of everyone involved of the potential for impacts of any development that will eventually and cumulatively affect the surrounding environment. The EIA process is designed to introduce opportunities early in project planning phases to consider choices and make decisions that will simply avoid the environmental pitfalls that might otherwise have occurred. This role of informing/educating the principal actors is of particular importance to aquaculture in Africa, because the opportunity is there, at this early stage in the growth of this sector, to develop the industry in an environmentally responsible manner, avoiding some of the setbacks that have been encountered in the past elsewhere. Some of these setbacks occurred through ignorance, but there is now a lot more knowledge about "best practice" options, such as those promoted by the Consortium on shrimp farming and the environment (FAO/NACA/UNEP/WB/WWF, 2006).

Given that resources are generally stretched in Africa, and that creating the institutional capacity to implement the EA regulations effectively presents a challenge, there is an argument in aquaculture for consciously allocating resources to this "educational" role as a priority. This would be about providing information to farmers about "best practice", but also going further and acquiring knowledge of potential impacts relevant to aquaculture and the sustainable options that could be made available to avoid or mitigate these. The sector should set itself ambitious objectives to develop environmentally favourable management options, providing farmers with the information to avoid or mitigate some of the industry's more intractable problems such the reliance on (imported) fish meal in fish feed.

Success in integrating "environmentally sustainable thinking" into sectoral and individual planning of aquaculture developments should lead to EIA processes becoming less onerous for the investor who is able to meet most standards at the screening stage of the process.

Added value from EIA: virtues of the best environmental credentials

A strong argument for gaining the support of farmers and investors for investing in the environmental dimension of operating an aquaculture business is the prospect of adding value by so doing. Even if the benefits would mostly only be felt in the long term, these could include more sustainable enterprises, with reduced risks of failure in the medium to long term.

A more immediate motive can come from access to premium markets that favour environmentally-friendly production methods and the price advantage these markets can offer. That African aquaculture can tap into these has been amply demonstrated by producers of shrimp, abalone and tilapia in Madagascar, Mozambique, South Africa and Zimbabwe.

Adherence to EIA and wider EA principles is a means of demonstrating high standards to potential customers. There is no reason why these qualities should not be recognized by domestic markets as well as the export markets that are the primary focus today. Furthermore, it is not an unreasonable objective to aim for virtually all aquaculture in Africa to be kept within the limits of international standards for certifiable aquaculture. The major local markets for fish will be urban and it can only be an advantage to have a positive image to project, and this would compare well with the widely held disparaging popular opinions of intensive poultry rearing, for instance.

Individual producers or groups of producers can go further and capture important niche markets by using ecocertification or eco-labelling schemes, similar to that being pioneered in Madagascar for *P. monodon* production with the support of the WWF and the Consortium on shrimp farming and the environment. This approach may be quite costly and not easy to achieve, but rewarding over the medium term.

STRETCHING BOUNDARIES OF EA FOR AQUACULTURE

Defining the boundaries for EIA

Since the advent of EIA as a project-level assessment, there has been a progressively more widely held conviction that the interactions between an activity like aquaculture and its environment go much further than the production site. This has seen the extension of impact concerns further out into the natural ecosystem and into the social and economic spheres. EAA (Ecosystem Approach to Aquaculture) is an alternative system boundary for analysing a sustainable aquaculture production sector (FAO, 2006; Soto, Aguilar-Manjarrez and Hishamunda, 2008).

One of the extensions to the boundary that needs to be considered for EIA is the inclusion of the additional impacts that will be generated not by the aquaculture producer itself, but the other businesses that grow to supply a producer or more likely a number of producers making up a successful aquaculture sector. These cumulative impacts could be substantial in the case of aquaculture becoming particularly successful in an area, despite the environmental performance of individual producers being quite acceptable as measured by project-level EIAs.

Perhaps the most intractable example of these "distant" impacts is that of the feed required for intensive aquaculture production. In many commercial systems large quantities of fish feed are required, including fish meal, which may have to be imported. There is of course potentially a significant impact at the site of production of the feed ingredients that may be outside of the producers' ecosystem, country or even continent, plus any long distance transport impact. At present EIA cannot really deal with these issues, although local feed production could be easier to include. One study made an estimation of the "ecological footprint" of tilapia cage culture on Lake Kariba (Berg *et al.*, 1996). Assuming that all the requirements were sourced locally including the fishmeal (based on kapenta), this study suggested that each 1 m^2 of cage production would be needed to be supported by the capacity of about 20 000 m^2 of lake surface. While these figures should be treated with care as they contain many assumptions and do not refer to real impact measurements, they do illustrate the scale of the problem that might occur. In Africa, as elsewhere, this puts the spotlight on the real impact of intensive aquaculture beyond the project site, bringing up both potential positives (agricultural opportunities, jobs) and potential negatives (agriculture market disruption, exceeding land production capacity).

Including assessment of these more extensive parameters is not practical in most cases for a project-level EIA with its limited objectives and short timescale. One option available is to use a wider perspective and employ a process called Strategic Environmental Assessment (SEA). This process is capable of seeing a "bigger" picture beyond individual projects and is a tool for including environmental considerations into policies, plans and programmes at the earliest stages of decision making, and which within certain limits could be a useful complement to environmental assessment in the context of aquaculture development.

Greater use of broad application of EA principles, such as SEA

Stategic Environmental Assessment or SEA could have a role to play in African aquaculture development, both at the level of preparation of sectoral policies as well as acquiring environmental data that would assist in project-level assessment. Some of the characteristics of SEA as compared with EIA are presented in Table 7, alongside suggestions of how this might apply to the aquaculture sector in Africa.

The main advantages are two-fold. Firstly, it would contribute to moving the whole sector forwards on a sound environmental level by improving strategy and sector policies that at present do not include sufficient attention to environmental impact (to satisfy even new national regulations). A strategic study is able to pro-actively identify

TABLE 7
Opportunity for use of Strategic Environmental Assessment for the aquaculture sector in Africa

EIA	SEA	Aquaculture SEA
Is usually reactive to a development proposal	Is pro-active and informs development proposals.	Looks ahead as aquaculture develops from a low initial level.
Assesses the effect of a proposed development on the environment.	Assesses the effect of a policy, plan or programme on the environment, or the effect of the environment on development needs and opportunities.	Ambitious policies for aquaculture need to be better informed of the risks and benefits attached to different options, and SEA could provide the data that is missing.
Addresses a specific project.	Addresses areas, regions or sectors of development.	Addresses countries, regions, waterbodies, catchments, wetlands, estuaries, mangroves, coastlines zonation of activities; estimates ecosystem carrying capacities;
Has a well-defined beginning and end.	Is a continuing process aimed at providing information at the right time.	Aquaculture is developing fast; attitudes and knowledge will change with time, and national strategies need to keep pace.
Assesses direct impacts and benefits.	Assesses cumulative impacts and identifies implications and issues for sustainable development	Provide baseline assessment for the sustainable growth of both commercial and small-scale producers. Aggregated impacts from concentrations of small operations needs management, especially out-grower schemes. Identifies cooperative solutions with other sectors competing for the same resources.
Focuses on the mitigation of impacts.	Focuses on maintaining a chosen level of environmental quality.	Environmental quality is high in Africa, which is attractive to aquaculture. SEA would set the environmental standards to be maintained
Has a narrow perspective and a high level of detail.	Has a wider perspective and a lower level of detail to provide a vision and overall framework.	Transfers some of the load from project level EIA by dealing with aquaculture in a wider regional or ecosystem context
Focuses on project-specific impacts.	Creates a framework against which impacts and benefits can be measured.	Creates a baseline of data on pertinent parameters against which future aquaculture impact can be measured. Identifies risk factors and potential benefits of aquaculture within the system being studied
Cost to individual investors/farmers	Investment for sector as a whole, either public or public/private funding	Possibly a better option for using scarce resources and expertise in Africa to maintain environmental standards with regard to aquaculture development. Aims to facilitate project specific EIA studies, making them quicker, more focussed and less costly

Source: adapted from Brownlie, Walmsley and Tarr, 2006; ECA, 2005.

opportunities within the legal, environmental and political constraints that may exist in a given area, region or coastline. Policies would benefit if SEA is able to include information, within the above constraints, on such aspects as the aquaculture “carrying capacity” of the region, options for optimal zonation that take into consideration other potential users, and the possible impact of other infrastructure that would be required. This would present an “enabling” insight to potential investors, large or small, and hopefully remove some of the apparent risk and uncertainty due to the fact there is little existing aquaculture to inspire and inform new entrants.

Secondly, the SEA can provide a platform of information and data that can make the outcome of an EIA easier to predict, thus lowering a possible barrier of entry for new investors. The present lack of baseline information means that a comprehensive EIA needs to acquire a lot of original data (physical, biological, social, economic) if it is going to seriously analyse potential impacts and their alternatives/mitigation. This is costly and for some time to come in Africa may be beyond the capacities of the expertise available to small and medium investors. The benefits of a SEA, implemented with these issues in mind, could include:

- a strategic framework to promote sustainable aquaculture;
- providing baseline environmental data and proposing minimum quality standards to be maintained;
- estimating carrying capacity of promising areas, zonation proposals;
- providing fundamental understanding of issues of "co-habitation" with existing activities;
- providing clearer interpretation of the EIA regulations such as criteria for the screening stage of EIA.

SEA is also potentially an easier process to use to look for broad win/win solutions between "opposing" stakeholders – promoters of different economic activities, conservationists or traditional community users of the resources. EIA, which is conducted for individual projects, usually for individual sites, has a tendency to become a battleground between opponents with fixed opinions.

Funding of strategic studies would be an issue, but if the above advantages can be realized this would seem to be a more productive and cost-effective way to use some of the scarce resources available in Africa. It would, however, be difficult to count on private "polluter pays" sources of finance which the current EIA system relies on at the moment. If SEA can be an effective contributing precursor to the establishment of an active commercial aquaculture sector, it is not unreasonable that this could be an action financed by public institutions or international development banks, and justified by the subsequent commercial activity of the aquaculture producers.

Using SEA procedures should not be about just adding another "layer" of institutional interference to economic aquaculture development. The objective should be to reduce the reliance on project level EIA and to provide comprehensive answers to the questions of environmental impact that are required by the legislation, thereby reducing the resources needed and cost of individual EIAs.

Zoning

Whether or not a SEA process is used, zonation could be a useful tool in promoting and managing aquaculture investment and growth in certain areas (Halwart and Moehl, 2004). Zonation is much more than a site identification exercise. It ensures a physical space for competing land/water users, and identifies areas which are suitable for aquaculture, where the impacts (particularly environmental impacts) of aquaculture development are acceptable within the limits that the SEA would determine. It removes potential conflict with other users, avoids unnecessary "sprawl" of development, and because many of the most attractive sites for aquaculture are also in or close to sensitive habitats, it can determine protected areas where development would not be permitted. EIA in such a context is rendered easier, and less off-putting to investors as the SEA removes a lot of the uncertainty of project planning. Establishing priority zones is also one route for the state to provide, by legislation or other means, for improved long-term access to resources such as land and water.

Zonation is a step that might help in launching a higher level of commercial investment, because apart from reassuring investors by identifying areas that are suitable, it could encourage some clustering of production, within the limits of local environmental carrying capacity, which brings with it opportunities for specialising professional roles such as in fry production, feed manufacture, or product processing. It may also be easier to provide infrastructure such as transport links, access to utilities and other links of a supply chain and marketing infrastructure. Egypt, with all its pressures on land and water, effectively operates a degree of zonation for agriculture/aquaculture/industrial users. Efforts are underway in South Africa studying how this might be done, but elsewhere this is an initiative that could stimulate interest in the sector from investors.

RISKS TO ACHIEVING EFFECTIVE EIA

Cost issues

Introducing the EA process has inevitably resulted in an "upfront" cost for a project, even if the long-term intention is to reduce cost to the environment and national economies by guiding developments towards sustainable options. This is an important issue in the context of aquaculture which is a new sector needing investment, which may well be difficult to come by in Africa where resources are generally stretched.

The extra costs are felt at several levels – the cost to the investor (under the "polluter pays" principle) of conducting the EIA, the cost to the oversight institutions (usually government authorities), and the cost to other stakeholders who want to participate in the EIA consultations. This applies not only to the initial studies, but also to the long term monitoring and audit that logically follow on from the initial study and approval. The principal costs are direct finance and the need to deploy trained personnel particularly within oversight institutions.

If the overall objective is to increase investment in the sector, there are questions that can be asked in the context of aquaculture in Africa. Firstly, can the sector as a whole, as well as individual projects, afford EIA and, second, does the prospect of paying that cost act as a dissuasive factor for investors?

EIA is a cost item that is just beginning to be included in African projects and even a few years ago this would not have been a part of the budget of a planned investment. Even now it does not apply to aquaculture in all countries, and in many it only applies to the largest projects. As to its affordability, this is difficult to judge. Two of the most significant investments in aquaculture to date which have conducted large EIA studies – Madagascar shrimp farms and Lake Kariba tilapia cage culture – have both used the fact of their attention to environmental concerns as a means to access premium export markets, effectively paying for their "investment" in EIA (among other environmental initiatives) with higher prices. It remains to be seen whether the impact of EIA costs on efforts to scale up the production of cheap food fish for local consumption will be a more significant constraint.

Cost will always be something of a barrier, and care must be taken by the sector that this is kept to the minimum necessary. Local investors in particular might not have easy access to finance and may well intend to build up the aquaculture production progressively, using revenue to finance incremental growth. In cases like this the prospect of a major "upfront" cost that does not immediately contribute to production could well be a "deal-breaker". The argument that in the long term the cost/benefit comparison will be favourable, and that the successful adoption of sustainable methods will make the EIA investment worthwhile eventually, has to be demonstrated by those promoting the sector and understood by potential investors. If this perception is not achieved, the result will be investors adopting other activities for which EIA is either seen as worthwhile or not required in the legislation at all.

It is not just the amount that an EIA study might cost that could be dissuasive, but also the level of uncertainty associated with the process. Initiating an EIA study is no guarantee of approval of the project and such variables as unpredictable stakeholder participation and influence, local politics, unpredictable study results, or conflicts arising that are beyond the scope of an aquaculture project (such as land tenure politics) can all lead to the failure of the proposal and consequent monetary loss. It is not possible – or desirable – for the proponents of a project to retain complete control of the consultation process once it is underway, and although such risks and their cost implications can be minimized, they can never be entirely eliminated. The proponents must be convinced that the risks are balanced by the fact that, overall, the process is likely to enhance the project's long-term sustainability (World Bank, 1999b). The Rufiji shrimp project incurred major costs in the approval process, including environmental assessments, and once the proposal had been blocked the local fishing company involved met with financial problems and had many of its assets seized. Although there are many factors involved here other than EIA, there is a link to the failure to complete the approval process and the potential risks are clear.

How should the EIA process be paid for? In most national regulations, particularly the most recent, the "polluter pays" principle is clearly stated. This means that generally the proponent pays for the application and EIA study itself, with varying investment required into organising public participation in the review of the proposal. The same applies for regular monitoring. However, there is more variation in the approach for financing the oversight activities by the national authority (UNEP/UNDP, 1999). In one option this is seen as a public service and the expense is ultimately met out of the public purse. In those cases there is often just a fairly inexpensive one off payment to have the initial application accepted and possibly a second one off payment to acquire the final environmental approval. The second option requires that the proponent pays fees, which can be substantial, to defray some of the expenses of the designated authority.

CLEAA, an African regional network representing environmental professionals, recommends two-part fee systems: (1) a processing fee, which supports the regulatory agency in the execution of its screening, scoping and EIA review responsibilities; and (2) a permit or license fee, which supports the regulatory agency in the execution of monitoring of the implementation of Environmental Monitoring Plans. Fees should scale to the size and complexity of the project (IUCN *et al.*, 2007). This is a model that a number of countries have adopted for all types of project subject to EIAs and three examples are given in Table 8 (the ranges indicated in the table have been calculated from the stepped thresholds used in the regulations for different levels of fees). It is possible that these levels of fees are more appropriate to major industrial projects such as mining, rather than for lower risk food production projects such as aquaculture. This could be reviewed and adjusted if necessary.

In fixing fees in this way there is a need to strike a balance between being realistic in terms of resources available to African investors in aquaculture and the desire of EA authorities and practitioners to secure finance for their work. At the same time without a minimum of resources for oversight, the EIA process will not really serve any useful purpose.

How can cost be reduced? Part of the answer to this question is to reduce the obligations for EIA/monitoring by demonstrating that aquaculture is not inherently a high risk to the environment, provided that the issues are understood by farmers/investors (education) and the choices for better and more sustainable options are taken early in the project cycle:

- by using SEA in appropriate situations to provide overall guidance in environmental issues and standards;
- by ensuring that the preliminary screening process eliminates the EIA as obligation wherever it is not really necessary, by using where possible a minimum threshold and a reduced assessment for recognized categories;

TABLE 8
Calculated examples of fees charged on a sliding scale as percentage of total project cost

	Madagascar	Zambia	Uganda
US$ project budget:	%	%	%
$30 000	0.5	7.2	0.5
$30 000 to $100 000	0.5	7.2–2.1	1.0–0.45
$100 000 to $500 000	0.5	10.8–2.1	0.45–0.15
$500 000 to $1 000 000	0.5	5.4–2.7	0.15–0.12
$1 000 000 to $10 000 000	0.5–0.3	5.4–0.54	0.12–0.1
1 US$	*1845 ariary*	*3860 kwacha*	*1750 shilling*

Source: EIA regulations of Madagascar, Uganda and Zambia.

- by a policy of openness with environmental data;
- in cases where full EIA study is required, to ensure that the scoping phase is used to carefully focus on key impacts rather than expecting a wide ranging "textbook" study.

Cost of environmental assessment and monitoring is therefore an issue that policy makers from both the aquaculture sector (as far as it is possible to negotiate a sectoral viewpoint) and environmental authorities should agree to monitor, in order to achieve a compatible arrangement that encourages the right kind of investment in sustainable aquaculture. Efforts should be made to avoid imposing unnecessary costs that would deter investors from entering this sector of great promise for Africa.

Issues of public participation

The environmental debate is evolving fast in Africa, and may well become a platform that populations and civil society will use to engage with government and business in tackling local, national or regional development. Most EIA regulations stipulate some kind of public consultation or participation in the decision-making process. The requirements vary widely and for some countries there may be just a brief mention of "public consultation" being required, while others are very prescriptive and specify at which stages this must be done, using designated methods and imposing a timescale and quality standards for information provided. Public participation is important to all effective EIA, not solely for aquaculture, and this an issue to be addressed by government authorities who so far have little experience of making it work. Aquaculture seems to have some issues that are commonly raised at the level of public consultation – notably around access to the key resources of land and water, and how this can be managed with minimum disruption. It is also likely that the communities affected will ask how they can participate in aquaculture at the same time, and projects might well benefit in being prepared to offer solutions to this before consulting the public. One option is to offer some local participation in a project, such as through an outgrower scheme linked to the principal farm, as has been proposed by the S.O.N. tilapia project in Uganda. In the case of Madagascar, however, the uncontrolled participation of small growers was not seen as desirable in the short term, due among other things to environmental risks and disease control, and the projects have taken particular care to consult regularly with the community and to offer other benefits.

Who is consulted during EIA activities, when, how and by whom will vary considerably from project to project, depending on project needs, but there are a number of reasons why this consultation is important, as outlined below in EIA guidelines from Malawi (Malawi/SDNP, 2007). To have the greatest chance of success, consultation needs to begin at an early stage, while critical project design decisions are still amenable to change (World Bank, 1999b). Effective public participation has a number of potential advantages for the project promoter:

- A project creates change which is unsettling but proposals are more readily accepted by people and government authorities if they are well informed.
- When people are informed, they are better able to appreciate the opportunities a project will have for them such as a job or a market for their goods and services.
- People in a project area have a wealth of knowledge and information about local conditions and consultation can help avoid EIA omissions and mistakes, and minimize adverse impacts on the community and their environment.
- In democratic societies people expect to be consulted about activities which will affect them and failure to consult them can result in problems for government and delays for project developers.

Information and communication are important to this part of the process and should be both comprehensive and in accessible language and form for the lay public, which for aquaculture means rural communities sometimes with low literacy. The importance of information in relation to public participation is demonstrated in the events surrounding the Rufiji shrimp project (Lissu, 1999). In this case the information to the public was initially provided late in the planning cycle of the project, although it had been debated and encouraged at high government level. Later, after the project had effectively been designed, considerable information was provided and a lively debate ensued in hearings, the media and eventually the High Court. Possibly early public consultation could have produced a different outcome. Although this experience has sensitized professionals, NGOs, the media and some communities to the utility of consultation in environmental decision-making, it is possible that the authorities – and in particular those responsible for major development investment – have not learned the lessons of this. More recent proposals for shrimp farming on Mafia Island, where much of the coastline has protected status, have been approved after EIA studies, although the local communities affected do not feel that they have been adequately consulted and that obvious risks of environmental impact have not been seriously considered.

Political will is an important ingredient in seeking sustainable solutions through the EIA process, particularly in the use of wide consultation of "stakeholders", and without it there is a risk that EIA becomes ineffective. There is political support for increasing investment in aquaculture in many countries, but this doesn't have to be incompatible with the EIA process, something that can be resolved by cooperation between sectoral authorities with aquaculture and environment responsibilities.

Land issues

Land tenure is important to aquaculture on at least two levels. Firstly, security of tenure is necessary to attract major investment into the sector. Secondly, the installation of a project in a rural community, where tenure is not a simple matter of buying private property, has to deal with finding solutions to disruption to existing access to land and water resources. This is often subject to unclear national legal frameworks and contradictions between state law and accepted traditional practice. Once opened up to public participatory debate there is a risk that it becomes a "make/break" issue for EIA (possibly independent of the potential benefits of an aquaculture project).

Land tenure arrangements in Africa are very variable, often with overlapping public/communal approaches and sometimes very controversial. They include private ownership, public/state "ownership" or "guardianship" and traditional tenure arrangements. It is common for the state to have a preponderant position as the final arbiter of land ownership especially outside urban areas, although land is often left to be used and exploited in a traditional manner by the local occupants. In some cases governments are accustomed to making major decisions about developments that affect land without considering local stakeholder positions. A fixed long-term investment like aquaculture (whether private or public) can then acquire land by application to state institutions. These can seem quite arbitrary top-down decisions to the existing traditional users of the land. This affects the EIA process, as the experience of the Rufiji Delta aquaculture proposals demonstrated. Public consultation is mandatory in most EIA rules and when it is implemented there is a risk of the forum becoming an opportunity for general land grievances to be aired to the detriment of reasoned consideration of the project situation. Where this happens it is possible that institutional stakeholders and investors become reluctant to allow EIA to become an open process, perceiving it as more of an unnecessary obstacle to progress.

The issue of land is not limited to private investment in commercial aquaculture, and it also affects the development of small-scale farming. In many places where land use is traditionally organized on a communal basis, fish ponds can disturb established modes of land occupation. The permanent nature of the pond infrastructure is very different to the normal cultivation/husbandry practice and building ponds can be used by individuals as a way of permanently "claiming" land previously perceived as communal. This can lead to conflict and loss of resources to the rest of the community. In the end this runs counter to sustainability and can lead to abandonment of the activity.

Risks of EIA becoming reduced to a paper based bureaucratic obstacle

A commonly cited risk in analyses of EIA systems is the tendency in Africa for these to lose the focus on mitigation of environmental impact and to become just another permit to be paid for. There may be several reasons for this, including the lack of institutional capacity to maintain a sufficient review and monitoring service, the lack of political will to use EIA properly, or simply that there is a generally poor understanding by applicants and administrators of the role of EIAs in the overall development project life cycle (Weaver and Sibisi, 2006). This concern applies equally to aquaculture, except that as mentioned above there is certainly the prospect that the industry can be persuaded of the self-interest in adopting sustainable environmentally friendly approaches. One factor in the aquaculture situation is that in many countries the sector is regulated by many sectoral laws (e.g. water, land) rather than by a specific "aquaculture" law. Where these sectoral laws are well established, such as in Egypt or South Africa, EIA approval might tend to be regarded by applicants as a relatively minor additional permitting process.

EIA, like many other authorization processes, also presents a risk of becoming just another delaying, costly and inefficient "rubber-stamping" exercise, poorly and bureaucratically managed by an under-resourced government department. It can only be hoped that recognition of this risk can lead to the public and private sectors working together to avoid it and keep the positive thrust of the EIA process on track.

Overlapping legislation and institutional roles

As has been noted in several of the case studies it can be difficult for a new environment agency to implement the environmental laws, in particular the EIA regulations, when individual sectors retain their own statutes governing approvals for projects falling within their sector (Adegoroye, 1996). Not all these sectoral statutes are inclusive of environmental concerns, and the introduction of the environmental agency into the "mix" becomes interpreted as unnecessary interference. This can lead to competition with line ministries for control of the legislation and of enforcement, or it may simply be a case of the sectoral line ministries having long-standing arrangements in place and there being resistance to change on the ground. In the end, the approach of the environmental agency must be "inter-sectoral" in nature and convincing them of the benefits of EA and working closely with line ministries is probably the only solution.

Access to environmental information

Information is a key ingredient of the EIA process, and is an issue on at least two levels for aquaculture in Africa – acquisition of the required information/knowledge, and wider access to that information.

There is relatively little information available about the environmental impacts of aquaculture in African countries, even for basic vital parameters such as water quality. Seeking and accumulating such knowledge into national and regional environmental databases will be an important step towards being able to improve sector planning and strategy, as well as sustainable implementation of individual projects. A strategic assessment approach can contribute to this, but sharing of information within the sector by both public and private sectors will be crucial and a vital role both for fisheries/aquaculture departments and private sector associations.

Clear policies to make this information easily available would be a positive step towards aquaculture development, and this includes clarifying whether or not the baseline data included in EIA studies, or preliminary assessment, should be made available. Several of the national frameworks include articles that specifically put this information in the public domain, in some cases with the proviso that confidential proprietary information be protected[11]. The latter condition should not be an obstacle to releasing most information relative to aquaculture projects. Despite these clauses it is still relatively difficult to obtain actual EIA documents, which project developers who have financed their preparation are perhaps unsurprisingly reluctant to reveal. Given that the documents are legally in the public domain, the environmental authority or aquaculture departments should try to take steps to make the information accessible, perhaps through Web sites, and in so doing contribute both to the confidence of potential investors and in fulfilling the obligations for public information contained in EIA legislation.

Implications of business applicants having control of EIA

Under the principle that the "polluter pays", most of the EIA regulations in Africa specify that the implementation and resourcing of the EIA study is the responsibility of the applicant. The EIS produced in this way are used as the basis for the approval decision to be made by the environmental authority, and this raises some important questions.

There is a real risk that the EIA study will be, or become perceived to be, partial and effectively promoting the applicants interests, rather than being an objective attempt to identify potential negative impacts and the mitigation measures that need to be taken. This could then slip through the approval process if there is not sufficiently sophisticated scrutiny (Katima, 2000). This is not a concern unique to Africa, and it is an accusation made against EIA in other situations. Given the commercial stakes for the businesses conducting these studies, this tendency should not be unexpected. The antidote to this is strong national institutions with the responsibility for oversight of each stage of the EIA process. However, most reviews of the EA in Africa at present indicate that the institutional capacity of environmental authorities still leaves much to be desired in terms of the resources, training and competence available. This is a deficiency that must be quickly addressed if EIA is to remain credible to the wider public.

A part of the solution to this is to ensure that adequately trained professional consultants (environmental assessment practitioners) are used to carry out the EIA study, and several national regulations make this mandatory[12]. This provides a motive to set up a recognized national register of practitioners who are available for promoters preparing a study. In some cases these national registers already exist and have a statutory basis, in other cases they are largely voluntary self-regulating bodies. There have also been efforts to organise the profession on regional and subregional

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[11] For instance: PART VIII. ACCESS TO ENVIRONMENTAL IMPACT STATEMENTS AND INFORMATION (United Republic of Tanzania, 2005)

Art. 39.-(1) Subject to the freedom of access to environmental information, any project brief, environmental impact statement, terms of reference, public comments, report of a person presiding at a public hearing, environmental impact assessment statement, decision letter or any other information submitted to the Council under these Regulations, shall be public documents.

(2) The Council shall, grant any person who desires to consult any document referred to in sub-regulation (1), access to that document on such terms and conditions as the Council considers necessary.

Art. 40.-(1) A person submitting information to the Council may at anytime apply to exclude the information or parts thereof from being made available to the public on the basis of commercial confidentiality or national security.

[12] For instance: Appointment of EAPs to manage applications (South Africa, 2006b)

Art. 17. (1) Before applying for environmental authorization of an activity, an applicant must appoint an EAP at own cost to manage the application.

General requirements for EAPs

Art. 18. An EAP appointed in terms of regulation 17(1) must –

(a) be independent;

(b) have expertise in conducting environmental impact assessments, including knowledge of the Act, these Regulations and any guidelines that have relevance to the proposed activity;

bases; see further below for these sub-regional groupings including EAAIA, SAEIA, WAAEA, SADC (CLEAA, 2004). Oversight and quality control will also need to be a preoccupation of the registration bodies, to avoid any perception that the "self-interest" of professional practitioners will influence their conclusions in favour of their employers" view and financial interests.

BIODIVERSITY ISSUES

Of all the topics surrounding the environmental impact of aquaculture in Africa, the most hotly debated is that of biodiversity. This can be affected by the introduction of alien species into aquatic ecosystems, the development of improved domestic strains of indigenous species through genetic selection, or eventually the creation of genetically modified organisms. Each of these potential threats needs to be looked at separately. "Introduction of alien species" can be taken to include translocation out of an area of natural distribution, even if that is within a country or sub-region of Africa[13]. Already these movements have had very significant impact on river basins, lakes and other waterbodies (Hecht *et al.*, 2006)

This is very relevant to EIA for most aquaculture projects, which so often rely on the translocation or importation of culture species. Not only would EIA almost certainly be evoked by the basic clauses of the regulations which make assessment necessary for "developments which are likely to have significant environmental impact", but in at least 16 countries the introduction of alien species or of GMOs is specifically listed as requiring EIA on its own merit. In one country (Comoros) the introduction of exotic species is simply banned.

What may not be clear is exactly how an EIA study can satisfactorily produce evidence in favour of an introduction, except in some unusual cases which are "exceptions that prove the rule". Three examples of these possible "exceptions" are:

- the introduction of a specialized species into a new man-made environment with no prospect of it spreading, and where there is no indigenous species available. The introduction of *Limnothrissa* into Lake Kariba is an example;
- the introduction of an alien species which is presumed not to be able to breed in local conditions if it does escape from aquaculture. Culture of grass carp, *Ctenopharyngodon*, as used for vegetation control in canals in Egypt either in areas where reproduction cannot occur or because sterile triploid fish are available;
- the introduction of an alien species by an aquaculture project situated in a catchment/ecosystem where it has already been introduced (illegally?) and become established in the wild. The use of *O. niloticus* in cage culture in Lake Kariba is an example of this.

The argument used to support this last case – that there is no prospect of eradicating the alien once it is established widely in the wild, and so no further harm can be done – is also an illustration of a fundamental argument against introduction in the first place – that introduction is usually irreversible, and ordinary "precaution" is no guarantee of avoiding this.

What are the issues facing project level EIA for introduction of an alien species?

- uncertainty is high about the impact should the species escape to the wild;
- there is no total mitigation to offer; total control of escape is not realistic except in high-tech bio-security infrastructure (hardly a sustainable option);
- EIA can suggest alternatives: this could be to use an indigenous species (most catchments/ecosystems in Africa have a large number of fish species) with the disadvantage that few of these have been tried/tested in aquaculture; in any case,

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[13] The term "Alien genotype" has often been used to indicate an organism is the same species as a local species, but contains genetic resources that differ from the local population. These differences can arise from genetic manipulation in a farm or from transferring genetically differentiated populations from other locations within the species' range..

genetic improvement of local species would lead to creation of "alien genotype" and there would be risks.
- a release/escape will in many cases have transboundary consequences in Africa, which under international conventions will require that other countries must participate in a decision (African Union, 2003);
- even if a project can demonstrate immediate economic returns from introducing a species, what price can the EIA put on the long term impacts on biodiversity in comparison?

In many cases national law and international treaties make a presumption that any introduction would be an extreme exception, although most leave some discretion presumably for those cases where there is assumed to be an urgent economic reason to do so. International guidelines such as the FAO CCRF and supporting Technical Guidelines on genetic resource management (FAO, 1995; 2008), or the ICES codes of practice (ICES, 2004) argue for the application of the precautionary approach and appropriate ecological risk assessment and management, taking the view that these introductions should be examined *a priori*, evaluated by EIA or other assessment and controlled.

The South African regulations provide a clear statement of the true implications of the "polluter pays" principle (South Africa, 2004):

"Should an alien species establish itself in nature as an invasive species because of the actions of a specific person, a competent authority may hold that person liable for any costs incurred in the control and eradication of that species"

This presents the decision to import a species as a clear business risk, and the downside is that eradication (even partial control) would almost certainly cost "millions". Reports from South Africa suggest that farmers there, once eager to import many exotic species, are already viewing this with much more circumspection and are now more likely to consider conducting research into local species.

Meanwhile, the African Convention on the Conservation of Nature and Natural Resources (African Union, 2003) also goes further than some international guidelines and contains articles that oblige signatories to strictly control not only the introduction of aliens but also the export from their own country "out of normal range" to another country. It also creates an obligation for states to eradicate alien species that are a threat to indigenous biodiversity.

Malawi illustrates the need to face up to difficult EA decisions in relation to this issue of biodiversity. The laws require EIA for introductions, but given the unique and extraordinary biodiversity of the fish in and around Lake Malawi, it is almost unthinkable that any fish introduction would be entertained. In fact in the past investors have proposed the farming of *O. niloticus*; this has been discarded for the alternative of *O. karongae* - a species indigenous to Malawi, despite this incurring extra cost in R&D for the investor.

The use of improved strains of indigenous fish is a quite different case. Aquaculture operations will inevitably, whether intentionally or not, lead to genetic changes in the domestic stocks. Deliberate selection for desirable characteristics is going to occur on farms, to the benefit of the sector. There are risks that can be identified in cases where the population or gene pool of the wild populations are small, but in the case of common species like the tilapia the likely impact of occasional escapes of conspecifics that mix with the wild population will be very small (Moehl, Brummet and Panzoni, 2006). Caution should be applied in any EIA analysis concerning the use of significantly altered strains, but the risk assessment study should be able to provide the information necessary for the decision to be made sensibly.

The case of GMO introductions is at present mostly theoretical, and unlikely to be acceptable given the current socio-political reluctance in Africa to allow introductions of any organisms in this category.

HUMAN RESOURCES AND INSTITUTIONAL CAPACITY

The capacity to carry out all the tasks that are required in implementing any environmental assessment has been widely identified as a key constraint to current EIA efficacy in Africa (Bekhechi and Mercier, 2002; EAAIA, 2007; Wood, 2003). This is reflected in a broad requirement for higher levels of staffing and competence covering both the public sector (the national environmental authority charged with oversight) and the private sector professionals who have the task of providing impartial expertise during the impact assessment process.

It is also important that the aquaculture institutions, most of which are in the public sector, should give a higher priority than at present to acquiring knowledge and expertise in environmental assessment as a useful asset for developing sectoral strategies and policies (Tekeu, 2004) and providing general assistance to aquaculture farmers. It would also enable them to better understand the processes and to be more effective in promoting better sustainable practice among farmers. At present aquaculture specialists tend to be quite unfamiliar with the requirements of EIA even in countries where aquaculture is a listed category that must be assessed. Interaction between investors and aquaculture agency/department professionals who are aware of the environmental issues, at an early stage of the project planning process will bring benefits to the sustainable qualities of the project as well as facilitate a more focused and efficient approach to the subsequent EIA process.

Training is available at many universities across the continent, as well as through initiatives such as CLEAA (Capacity Development and Linkages for Environmental Assessment in Africa) as well as UNEP (Sadler and McCabe, 2002) and the United Nations University (UNU[14]). CLEAA is a pan African network facilitating EA development across the continent (CLEAA, 2007a). They offer courses in project level EIA, SEA, follow up and post-implementation monitoring, EA and public participation, integrating HIV/AIDS in EA processes, integrating biodiversity issues, managing EA processes and quality control (reviewing) of EAs, although there is no specialist training directed towards aquaculture.

The total requirements for trained personnel will fluctuate with the EIA workload that is generated by economic development, but it has been pointed out that state trained personnel, already too few in number, have a tendency to leave public service where the private consultancy opportunities are more attractive.

Quality control of environmental assessment practitioners would also need to be built into the system, and already some countries, such as Uganda and South Africa, have screening and registration processes for private consultants who are approved by the environmental agency for work on EIA.

INTERNATIONAL LINKS ACROSS AFRICA

International links between African countries provide a number of benefits, enabling the region to share experiences in the broad field of environmental assessment, whether they are positive or negative. The use of EIA, including for aquaculture, is being introduced across the continent and there are opportunities for mutual exchange at several levels including of technical data, law, enforcement, expertise and training.

The political will to address the problems of the environment facing the continent are already being addressed in a number of fora such as the African Union (through the New Partnership for Africa's Development – NEPAD), and the African Ministerial Conference on the Environment (AMCEN). There are also treaties such as the African Convention on the Conservation of Nature and Natural Resources, which deal with several transboundary issues relevant to EIA – see below.

[14] EIA Open Educational Resource - http://eia.unu.edu/

Specific networks have been established to develop and improve the implementation of EA in Africa, most notably those under the umbrella of CLEAA (Capacity Development and Linkages for Environmental Assessment in Africa, CLEAA, 2007a), which includes the following sub-regional groupings:

- Southern African Institute for Environmental Assessment (**SAIEA**);
- Eastern Africa Association for Impact Assessment (**EAAIA**);
- West African Association for Environmental Assessment (**WAAEA**);
- Indian Ocean Islands Association for Environmental Assessment (**IOAEA**);
- Secretariat for the Environmental Assessment in Central Africa (**SEACA**);
- Community Based Impact Assessment Network for Eastern Africa (**CIANEA**);
- Tunis International Centre for Environmental Technologies (**CITET**) for North Africa**.**

There are also similar networks dedicated to regional cooperation in aquaculture, such as the **CIFAA** (Committee for Inland Fisheries and Aquaculture in Africa) and **ANAF** (Aquaculture Network for Africa), which also provide a forum for the discussion of environmental issues (Aguilar-Manjarrez, 2008; Barg *et al.*, 2008).

International (regional) harmonization of legal approach – African Convention on the Conservation of Nature and Natural Resources

There are clearly important international dimensions to the management of the environment in Africa and many aquaculture initiatives could have far reaching transboundary impacts, e.g. the shared aquatic resources of the Great Lakes of eastern and southern Africa (cages, water pollution, alien introductions) or the major river basins (UNEP/UNDP, 1999).

In a step to harmonize the approach of all countries to these transboundary issues forty-four African countries are party to the African Convention on the Conservation of Nature and Natural Resources under the auspices of the African Union (2003). This treaty provides for cooperation and statutory coordination across the continent. Summarized below are some of the relevant clauses that require countries to make provision for EIA and SEA type approaches in managing their environment:

"Art.XIV.b….ensure that policies, plans, programmes, strategies, projects and activities likely to affect natural resources, ecosystems and the environment in general are the subject of adequate impact assessment at the earliest possible stage and that regular environmental monitoring and audit are conducted" (African Union 2003);

The treaty also calls for strict controls on alien introductions:

"Art XI.2.h. …strictly control the intentional and, in as far as possible, accidental introduction, in any area, of species which are not native to that area, including modified organisms…"

But goes further by calling for states to:

"…endeavour to eradicate those already introduced where the consequences are detrimental to native species or to the environment in general";

As well as creating an obligation to control exports of alien and GMO organisms:

"Art XX.f …the Parties shall, prior to the export of… alien or modified organisms, undertake to secure the prior informed consent of the importing, and where appropriate, transit States";

This is an interesting extension to internal state responsibilities, although there are no records of this clause being invoked in the transfer of fish species whether for aquaculture or not.

EVOLVING INTERACTION OF AQUACULTURE WITH EIA AND ENVIRONMENTAL MANAGEMENT

This document has discussed some of the issues relating to the use of EIA for aquaculture in Africa, but it is only a snapshot in a dynamic situation. Looking at current events it is clear that activities, regulations and institutions within both sectors – aquaculture and environmental management – are undergoing change all the time.

If the high expectations for the development of aquaculture in the African region do become reality, we can expect the rate of change in these matters to accelerate as production sites increase in size and number. The widely enacted EIA regulations will come into their own as a management tool once there is real experience of the consequences of environmental impact as a result of the success of the sector.

In the short term, there is scope for environmental management agencies to put greater priority into the implementation of those aspects of the regulations that provide for monitoring and audit of aquaculture projects once they have been approved and put into operation, and so acquire the data to assess the real environmental costs and benefits of aquacultural activities.

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Review of environmental impact assessment and monitoring in aquaculture in Asia-Pacific[1]

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ABSTRACT

This review is prepared as part of the FAO Project "Environmental Impact Assessment (EIA) and monitoring in aquaculture". The review provides a compilation, review and synthesis of existing EIA and environmental monitoring procedures and practices in aquaculture in the Asia-Pacific region, the largest aquaculture-producing region in the world. This review, as in other regions, gives special consideration to four areas related to EIA and monitoring in aquaculture including: (1) the requirements (2) the practice (3) the effectiveness and (4) suggestions for improvements. Australia, China, India, Indonesia, Japan, Malaysia, the Philippines, Thailand and Viet Nam are covered in some depth, and a brief overview is provided of EIA and monitoring in several other countries in the region that are in various stages of adoption and implementation of environmental impact assessment, monitoring and other environmental management measures for aquaculture.

[1] This regional review is a contribution by the Network of Aquaculture Centres in Asia-Pacific (NACA)

The review synthesis provides an overview of the current status of EIA and monitoring in the countries around the Asia-Pacific region and provides a number of recommendations for future improvements in the environmental management of aquaculture.

CONTENTS

Acronyms and abbreviations

ADB	Asian Development Bank
AGIP	Aquaculture Ground Improvement Programs (Japan)
AMDAL	*Analisis Mengenai Dampak Lingkungan Hidup* (Management of Environmental Impact Analysis) (Indonesia)
ANDAL	*Analisa Dampak Lingkungan Hidup* (Environmental Impact Assessment) (Indonesia)
AQSIQ	General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China
ASEAN	Association of South East Asian Nations
AVS	Acid Volatile Sulphide
BFAR	Bureau of Fisheries and Aquaculture Resources (The Philippines)
BMPs	Better (or Best) Management Practices
BOD	Biochemical/Biological Oxygen Demand
BOU	Benthic Oxygen Uptake
CAA	Coastal Aquaculture Authority (India)
CAQS	Centre for Agri-Food Quality and Safety (China)
CNCA	Certification and Accreditation Administration (China)
CoC	Code of Conduct
COD	Chemical Oxygen Demand
CoP	Code of Practice
CZMAs	Coastal Zone Management Authorities (India)
DA	Department of Agriculture (The Philippines)
Danida	Danish International Development Agency
DAO	Department Administrative Orders (The Philippines)
DARD	Departments of Fisheries (Viet Nam)
DENR	Department of Environment and Natural Resources (The Philippines)
DO	Dissolved Oxygen
DOE	Department of the Environment (several countries)
DOF	Department of Fisheries
DONRE	Department of Natural Resources and Environment (Viet Nam)
ECA	Environmentally Critical Areas (The Philippines)
ECC	Environmentally Compliance Certificate (The Philippines)
ECP	Environmentally Critical Project (The Philippines)
EI	Environmental Impact
EIA	Environmental Impact Assessment
EIS	Environmental Impact Statement
EMB	Environmental Management Bureau (The Philippines)
EMP	Environmental Management Plan(s)
EMS	Environmental Management Systems
EOs	Executive Orders (The Philippines)
EPA	Environmental Protection Agency (several countries)
EPB	Environmental Protection Bureau (China)
EPBC Act	Environment Protection and Biodiversity Conservation Act (Australia)

EPRMP	Environmental Performance Report and Management Plan (the Philippines)
EQA	Environmental Quality Act (Malaysia)
EQS	Environmental Quality Standards
ESD	Ecologically Sustainable Development
FAO	Food and Agriculture Organization of the United Nations
FAO	Fisheries Administrative Order (the Philippines)
FARMC	Fisheries and Aquatic Resources Management Council (the Philippines)
FCA	Fisheries Cooperative Association (Japan)
FEMC	Fishery Environment Monitoring Center (China)
FEMN	Fishery Environment Monitoring Network (China)
GAP	Good Aquaculture Practices
GBRMPA	Great Barrier Reef Marine Park Authority (Australia)
GESAMP	Group of Experts on the Scientific Aspects of Marine Environmental Protection
GIS	Geographical Information Systems
GMO	Genetically Modified Organism
ICAR	Indian Council of Agricultural Research (India)
IEE	Initial Environment Examination
ISO	International Standards Organization
JFRCA	Japan Fisheries Resource Conservation Association
LGU	Local Government Units (the Philippines)
MAFF	Ministry of Agriculture, Forestry and Fisheries
MARD	Ministry of Agriculture and Rural Development
MMAF	Ministry of Marine Affairs and Fisheries (Indonesia)
MMT	Multi-partite Monitoring Team (the Philippines)
MoA	Ministry of Agriculture (China, India)
MoE	Ministry of Environment (several countries)
MoLR	Ministry of Land and Resources (China)
MONRE	Ministry of Natural Resources and Environment (Viet Nam)
MoWR	Ministry of Water Resources (China)
MPEDA	Marine Products Export Development Authority (India)
NACA	Network of Aquaculture Centres in Asia-Pacific
NaCSA	National Centre for Sustainable Aquaculture (India)
NALO	National Aquaculture Legislation Overviews (FAO)
NASO	National Aquaculture Sector Overviews (FAO)
NEB	National Environmental Board (Thailand)
NGO	Non-governmental Organization
NOC	No Objection Certificate (India)
NORAD	Norwegian Agency for Development Co-operation
NSW	New South Wales (Australia)
OECD	Organisation for Economic Cooperation and Development
PCR	Polymerase Chain Reaction
PD	Presidential Decree (the Philippines)
PEPRMP	Programmatic Environmental Performance Report and Management Plan (the Philippines)
PHILMINAQ	Mitigating Impact from Aquaculture in the Philippines (EU project)
RAS	Recirculating Aquaculture Systems
RIA	Research Institute for Aquaculture (Viet Nam)
SEA	Strategic Environmental Assessment
SEPA	State Environmental Protection Administration (China)

SEZ	Special Economic Zone
SOA	State Oceanic Administration (China)
SS	Suspended Solids
TCVN	Vietnamese Environmental Standards
TOL	Temporary Occupation Land (Malaysia)
TOR	Terms of Reference
TSS	Total Suspended Solids
UNDP	United Nations Development Programme
VND	Vietnamese Dong (currency)

Summary

BACKGROUND

Countries in the Asia-Pacific region began to establish environmental legislation in the 1970s, and Environmental Impact Assessment (EIA) was an important area for many regulations. Since their inception, most of the EIA laws in the region have been amended in order to expand their coverage, enhance administration and public participation, and improve enforcement. The EIA systems found in the region have significant differences from country to country, particularly with respect to EIA requirements, administrative frameworks and responsibilities, implementation capacity, degree of public consultation and information disclosure, duration and the need for an environmental management plan. The general framework for EIA has an important influence on the application of EIA and monitoring to aquaculture within each county, where it may or may not be considered in EIA legislation as an activity with potential environmental impacts.

EIA AND AQUACULTURE

There are significant differences from country to country in the requirements for EIA or environmental monitoring for aquaculture. The requirements can be summarised as follows.

- Countries in the region include those in which aquaculture projects are specified in EIA legislation, such as the Philippines, and those, such as Thailand, that do not include aquaculture in EIA legislation. In the latter, environmental management responsibilities for aquaculture usually lie within the responsible fisheries and aquaculture ministries and departments.
- The scope of EIA, when applied to aquaculture, is almost entirely focused on individual, large-scale aquaculture, projects.
- EIA legal requirements are commonly focussed on high value, intensive farming, and particularly shrimp and marine cage farming in tropical areas and marine fish farming in temperate areas.
- Strategic environmental assessment (SEA) is a new concept to the region. As of 2005, only China, Hong Kong SAR, Japan, Korea and Viet Nam have legal requirements, to a certain extent, for SEA at national or local levels, or for aquaculture plans. Australia provides one example where environmental assessment is conducted on proposed aquaculture zones in coastal areas, which can be considered a form of SEA.
- Administration of EIA is usually within environmental ministries or departments. In the absence of EIA legislation including reference to aquaculture, the environmental assessment and management of aquaculture usually occurs under wide range of laws, often with key ministry of fisheries or equivalent. The need for improved environmental management of aquaculture is recognised widely, but the regional trend appears to be towards enhanced responsibilities for the sectoral ministries or departments involved with aquaculture.
- Decentralisation of government responsibilities, occurring widely across the region, is leading to delegation of some environmental management decisions from central to local government authorities. This process is leading to more administration and decision-making associated with EIA, and more generally the environmental management of aquaculture, at lower administrative levels. This approach raises considerable challenges, due to limited capacity for

environmental management at local levels, and sometimes unclear or overlapping legal responsibilities and procedures.
- EIA legislation for aquaculture widely includes reference to Environmental Management Plans (EMPs) that include environmental monitoring. Environmental monitoring programs involving aquaculture and the environments where aquaculture is practised are being more widely conducted, usually under larger government monitoring programs outside of EIA procedures. Examples can be found in the extensive environmental monitoring networks for fisheries in China and the developing systems in Viet Nam, both of which involve substantial investment.
- Some general EIA guidelines are now widely available to guide practitioners, but there are fewer focused on aquaculture sector.
- Voluntary instruments or "soft-law" (such as Codes of Conduct or Good Aquaculture Practices) are increasing in number; some linked to certification schemes and market access requirements. These are operated by governments, and also by some NGOs or private sector associations. The increasing proliferation of such instruments and certification schemes appears to be in response to market demand, particularly with exported products, and food safety concerns associated with aquaculture products. The scope and content of these documents varies considerably across the region, and there is a need for better harmonisation of content and approaches.
- Public participation and transparency are widely required in EIA legislation, but the requirement appears to be implemented widely in only a few more developed countries/territories within the region.

PRACTICES

Successful implementation of EIA requires skilled people, access to assessment and monitoring methods, financial and institutional support, and monitoring and enforcement powers, amongst others. The availability of such resources across the region has improved significantly over the past decade, but as can be seen from the various country papers, there is still a noticeable lack of capacity and resources for environmental assessment and management of aquaculture. The status of current practices is summarized as follows.
- Legislation is widely in place, but environmental assessment of aquaculture is still practiced unevenly across the region. The scope of most environmental assessment is oriented towards larger scale projects, with limited consideration of small-scale projects, or the cumulative impacts of large numbers of small-scale aquaculture activities. In terms of the wider environmental impacts of aquaculture in Asia, the effectiveness of EIA as a single tool for environmental management is therefore reduced, as most aquaculture development in Asia is small-scale.
- Methodologies used and the coverage of major environmental issues in environmental impact assessments in practice is also variable. In many lesser-developed countries, where conducted, the focus is in practice mostly on water and sediment quality, which are more easily analysed, and onlimited habitat descriptions, with less emphasis on ecological aspects and ecosystem functions. In part, this is a result of limited skills and available methodologies, and limited awareness, resources and capacity for environmental assessment.
- Modelling of carrying capacity and effluent impacts is an important area where the methods are not widely available or skills not in use. In particular, lack of widely available carrying capacity models is noted, although there is increasing interest in development of models relevant to the region's aquaculture.
- The use of risk-based methods in environmental impact assessment is limited. Only in Australia (and possibly New Zealand) is risk analysis now starting to be used as a methodology for environmental impact assessment.

- Environmental monitoring of aquaculture areas is now being practiced in several countries across the region, but with widely varied and in some cases inappropriate water quality standards. Widely varied water quality standards are found across the region and some standardisation would be useful. Environmental monitoring in individual aquaculture projects as a follow up to EIA is practiced to a very limited extent in most countries, with limited feedback to management improvements or project development.
- Environmental monitoring investments, more generally, and specifically as a follow up to EIAs, are needed in many countries to be better connected to management measures.
- There is increasing interest and practice in the use of voluntary instruments or "soft law" for management of aquaculture, particularly for exported major commodities such as shrimp. These instruments include Codes of Conduct, Codes of Practice, Good Aquaculture Practices, Better Management Practices and other standards and certification schemes.
- Delegation of responsibilities for environmental assessment and management of aquaculture to local authorities under decentralisation policies, such as in Indonesia and the Philippines, brings government managers closer to the farms and has considerable potential to improve environmental management of aquaculture, although implementation is constrained by lack of capacity and financial resources at the local level, as well as lack of clear or complete delegation of responsibilities in others (e.g. Indonesia, Philippines).
- Unclear institutional responsibilities and unclear jurisdictions in practice for environment agencies and sectoral agencies involved with aquaculture are raised as issues in several countries.
- Review processes and degree of consultation are extremely limited in nearly all countries, except for more developed countries/administrative regions in East Asia and Australia. Greater involvement of local stakeholders in the environmental assessment process and monitoring has potential to improve effectiveness and reduce costs.
- Impractical or inappropriate environmental management recommendations, which are not affordable or feasible, is also a concern. The need for practical environmental management measures that are affordable and feasible for farmers is evident from the review.

EFFECTIVENESS

For many countries in the region, the use of formal EIA and monitoring requirements and practices may have had limited effect on the wider aspects of management of environmental impacts of aquaculture at the country or regional scale. The major reason is that formal EIA tends to be focused on large scale individual projects, and much of the development of aquaculture in Asia is associated with small-scale aquaculture, often household level farming, making adoption of formal EIA procedures extremely difficult on an individual farm basis.

The fast pace of aquaculture development, and some sectors such as shrimp and catfish culture, has also made it difficult for environmental regulatory systems to keep pace. Project-based or sectoral EIA should therefore be seen as one tool in an environmental management strategy for aquaculture, to be combined with other measures for an effective overall approach.

Increasingly, voluntary instruments and "soft law", linked to market access schemes such as certification, are now being used by governments and some private industry stakeholders to improve environmental performance, building on, or as an alternative to, more formal EIA measures. Emphasis in such schemes is towards high value commodities traded on international markets, where quality, and particularly food safety, are important concerns. There is some evidence that the effectiveness of such voluntary measures, combined with major extension activities, such as in India, has contributed to improved environmental performance, but there is a need for wider application. Further assessment of the environmental benefits of voluntary schemes, such as in India, would be useful to guide future approaches.

Some other key points related to the effectiveness of EIA and monitoring include:

- Potential environmental impacts associated with the aquaculture industry are widely known, but awareness of these potential impacts is not always translated into environmental impact assessments or monitoring.
- In general, the use of data generated by the EIA or ongoing monitoring (by investors, producers, regulators, etc) beyond the immediate EIA appraisal is extremely limited in most countries.
- On-farm use of environmental data, generated through formal or informal environmental monitoring procedures, also appears to be limited in most countries.
- Feedback mechanisms for regular revision and review of the legal requirements for EIA and monitoring procedures and practices exist, and some improvements for aquaculture are being made.
- The general perception of stakeholders (producers, environmental and other NGOs, scientists, etc) about the effectiveness of the requirements is difficult to assess in most countries, without more detailed in-country consultations. The overall "feeling" is that EIA is useful, but it has not always contributed to improved environmental management of the sector, and is viewed more of an administrative burden rather than a management tool.
- More emphasis on addressing small-scale farmers is needed, perhaps through more widespread promotion and use of strategic environmental assessment and regional or sectoral level planning, and voluntary measures that are inclusive of the small-scale farming sector.

IMPROVEMENTS

There are opportunities for improvements to the environmental impact assessment and monitoring related to aquaculture in the Asian region, and more broadly environmental management in the aquaculture sector. Factors that are important in driving improvements to environmental assessment and management of aquaculture in the region include political will, awareness of the need for and potential positive industry benefits from improved management, investment, capacity and trade/marketing issues. The latter in particular have driven several countries to make significant improvements in environmental management through development and investment in implementation of codes and better practice guidelines, with some demonstrated environmental improvements. The following summarises some opportunities and recommendations for improvement:

- Strengthening of legislative systems and clarification of responsibilities for environmental management of aquaculture, both horizontally (between environment and aquaculture sector agencies) and vertically (central to local levels) continues to be needed.
- Improvements in environmental assessment related to scale of project, and levels of risk are needed. The single project approach to EIA, only applicable in practice to large-scale projects, should be complemented by assessments at regional or sector level, and related to the degree of environmental risk. SEA (Strategic Environmental Assessment) legislation is increasingly available, but has seen limited application to aquaculture.
- Considerable initiatives are being taken across the region to improve environmental performance of aquaculture by sectoral agencies (e.g. department of fisheries) and

industry. There has been and is a shift in awareness in government agencies towards the need for better environmental management of the sector, rather than solely promotion of production. This awareness, and associated political will, provides opportunities to introduce improved environmental assessment measures into the process of aquaculture planning and approval where these measures lie outside of environmental agencies. Sectoral agencies with management responsibilities for aquaculture should be encouraged/supported to adopt more environmental management measures and also encourage development and adoption of codes and other voluntary instruments within the private sector. Regional and international cooperation is also necessary to ensure better harmonisation and improved equivalence arrangements in the use of such instruments.

- The scope and use of environmental monitoring for management should be improved. There are good examples of monitoring programs for aquaculture areas, for example the environment and disease monitoring system of fisheries and aquaculture in China, and recently established also in Viet Nam. These initiatives can be improved though by development of standards and indicators, improved data analysis, and creating better links to management. This will require improvements in data collection, handling and processing, and opening up of communication channels vertically and horizontally to responsible government agencies and industry stakeholders.
- There is a need to improve environmental assessment methods and make them widely available.
- Carrying capacity models need to be more widely available, tested and suitable models promoted. Calculations in the EIA to assess carrying capacity of the waterbody and the farms should take into account the other farms in the waterbody and not only individual farm projects.
- Opportunities provided by decentralisation for improvements in local environmental management have not been translated widely into practice because of weak local institutional capacities and sometimes unclear delegation of responsibilities. Capacity building and guidelines to support such initiatives are needed.
- Use of EIA in aquaculture should be brought to an earlier stage in the project cycle with advocacy of more emphasis on EIA and SEA on aquaculture plans or areas. Capacity building and sharing of information on strategic environmental assessment would be one way to promote more widespread testing and adoption of this tool.
- The private sector pays for the conduct of most project-based EIAs, involving mainly larger farms. There is a need to explore means of financial support for the small-scale sector to participate in environmental management schemes, including voluntary schemes.
- Public participation mechanisms, including wider stakeholder involvement in the development of voluntary instruments, should be strengthed to ensure industry ownership and acceptance by public at large.
- The risk analysis approach should be more widely adopted in EIA processes and procedures, to enable focus on key issues and simplified procedures for addressing registration/licensing requirements for large numbers of small farms. Risk analysis can also be used to refine and focus EIA on key issues, and move away from over-simplistic area-based requirements for EIA (e.g. EIA on farms > 50 ha), particularly to target and to focus on key environmental issues related to particular farming systems and locations.
- Much stronger emphasis is also needed on improving environmental management among the small-scale farming sector, through simple regulatory procedures and voluntary measures that support improved environmental management, assisted

by improvements in the financial and technical services that will support the transition to better management. Costs associated with such management also need to be carefully considered; as it is unlikely the management costs can and should be absorbed by the small-scale producer.

Background and scope

"EIA and monitoring in aquaculture" – Component 2 of the FAO Project "Towards sustainable aquaculture: selected issues and guidelines" – includes the compilation, review and synthesis of existing EIA and environmental monitoring procedures and practices in aquaculture. Regional case studies were undertaken to review these issues in selected countries of four composite regions. This review covers the Asia-Pacific region, and specifically the following countries: Australia, China (including China, Hong Kong Special Administrative Region [SAR]), India, Indonesia, Japan, Malaysia, the Philippines, Thailand and Viet Nam. Additional information is also included from Bangladesh, Republic of Korea, Sri Lanka and New Zealand. For each country covered the focus of study is on the top three aquaculture species/commodities produced, although in many cases the status of EIA implementation is such that there is limited difference in approach or implementation between the species/commodities, or farming systems in each country. This case study review for the Asia Pacific region, as in other regions, gives special consideration to four areas related to EIA and monitoring in aquaculture including: (1) the requirements (2) the practice (3) the effectiveness and (4) suggestions for improvements, according to the Terms of Reference outlined in Appendix 1. The preparation of this review is based on country reviews contributed by several authors, which were coordinated and synthesized by M. Phillips of the Network of Aquaculture Centres in Asia-Pacific.

Authors collected information through a number of country analysts responsible for collection of information from each country. Each country analysis was compiled from relevant information as available in sources such as the scientific literature, professional and trade journals, grey literature, internet, regulatory authorities, industry associations, aquaculture or fisheries societies, environmental organizations and individual experts. Additional supplementary information was obtained through a workshop on carrying capacity of aquaculture, held by the Australian Centre for International Agricultural Research, Directorate General of Aquaculture (Indonesia) and the Network of Aquaculture Centres in Asia-Pacific (NACA) held in Lampung, Indonesia, during November 2007 (McKinnon, 2007).

It proved difficult to obtain detailed information on the implementation of EIAs and environmental monitoring in aquaculture in practice, and particularly to analyse in detail the implementation status. Insufficient, lacking or inaccessible information on "practices" and "effectiveness" in some countries was a particular constraint. Nevertheless, it is hoped that the synthesis and review as compiled provides a further stepping-stone of information towards improving the environmental management of the aquaculture sector in Asia. Furthermore detailed reviews of some countries, such as China, India, Malaysia and the Philippines would be warranted, from central to local levels, to provide insight on procedures and practices for environmental management of aquaculture. Such analysis, facilitated in a participatory way involving stakeholders from local to central levels, could also open opportunities for dialogue on improvements in environmental management, recognized as a particularly high priority at the present time in China.

General information on status and trends of aquaculture developments in Asia-Pacific can be found in FAO Fisheries Department (2006), NACA (2006), as well as

NACA's Web site[2] and FAO's National Aquaculture Sector Overviews[3] and National Aquaculture Legal Overviews[4].

[2] NACA: www.enaca.org/
[3] National Aquaculture Sector Overviews: www.fao.org/fishery/naso/search/en
[4] National Aquaculture Legal Overviews: www.fao.org/fishery/nalo/search/en

Synthesis of findings

REQUIREMENTS

General aspects of EIA legislation

Countries in the Asia-Pacific region began to establish environmental legislation in the 1970s, and environmental impact assessment (EIA) was an important area for many regulations. EIA systems and laws were gradually implemented across the region, from the 1970s (e.g. Japan and the Philippines), the 1980s (e.g. China and China, Hong Kong SAR, Indonesia, Republic of Korea) and the 1990s (e.g. Cambodia, Thailand, Viet Nam) and in 2000 (e.g. the Lao People's Democratic Republic). Since their inception, most of the EIA laws in the region have been amended in order to expand their coverage, enhance administration and public participation and improve enforcement.

The EIA systems found in the region have significant differences from country to country, as noted in a recent review (World Bank, 2006; 2008a), particularly with respect to:

- *Coverage of the EIA requirements*, such as the type and size of projects or plans. A growing, but still small, number of countries identify the need for EIA on development plans (as opposed to individual projects), including the use of strategic environmental assessment (SEA).
- *Administrative frameworks*. Across the region a range of bodies have been established to manage and implement EIA policy and regulations. Typically this involves ministries of environment or government environment agencies assuming most of the responsibility. The sector ministries, such as those for fisheries and aquaculture, tend to be responsible for sector specific technical guidance. In most cases the environment ministry is required to coordinate with these sector ministries for projects at the national level, but often communication channels are poorly developed for various reasons.
- *Capacity to implement EIAs*. The EIA procedure typically includes the following features; preliminary investigation, formulation of terms of reference (ToR), scoping, baseline study, environmental impact evaluation, mitigation measures, assessment of alternatives, final reporting, decision-making and project monitoring, requiring skilled professionals and financial resources. General guidance materials for EIA practice are widely available, as noted in the bibliography (for example, Sadler and McCabe (2002) and UNU (2007), and in a number of countries government officers and professionals have received extensive training. This capacity is however not evenly distributed in the region and, as will be seen, much less so for aquaculture activities.
- *Public consultation and information disclosure*. An essential step in identifying potential environmental impacts and designing effective mitigation measures is the public consultation process, and this process is stipulated in all the EIA laws and regulations in the region. Some countries/governments (and China, Hong Kong SAR) are reported by the World Bank (World Bank, 2006) as having adopted best practices with wide public involvement, but others less so. Effective public participation relies on the availability of appropriate information, access to which not surprisingly varies considerably across the region. Access to completed EIAs was a constraint to preparation of this regional review.
- *Timing*. The timing and duration for clearance of EIA reports varies considerably from country to country.

- *Environmental management plan (EMP).* The need for an EMP is widely stipulated in the EIA requirements across the region, but not monitoring. For example, the World Bank (World Bank, 2006) report that in Cambodia, Thailand and Viet Nam follow-up monitoring is not included as a requirement within EIA legislation.

This general framework for EIA has an important influence on the application of EIA and monitoring to aquaculture within each county, where it may or may not be considered in EIA legislation as an activity with potential environmental impacts.

EIA and aquaculture

There are significant differences from country to country in the requirements for EIA or environmental monitoring for aquaculture. The requirements can be summarized as follows:

- The region includes countries in which aquaculture projects *are* specified in EIA legislation, such as the Philippines, and those, such as Thailand, that *do not* include aquaculture in EIA legislation. In these latter countries, environmental management responsibilities for aquaculture usually lie within the responsible fisheries and aquaculture ministries and departments. Table 1 provides further details.
- The scope of EIA, when applied to aquaculture, is almost entirely focused on individual, large-scale aquaculture, projects. Countries differ in the thresholds that trigger an EIA, which are usually focussed on projects covering larger areas, commonly between 10 ha and 50 ha. Scale, production capacity or area may be specified as criteria for triggering an EIA. Small-scale aquaculture farms are generally not subject to EIA, although they may be subject to environmental screening, or other environmental management strategies outside the EIA legislation (e.g. licensing, Good Aquaculture Practice (GAP) regulations, managed by the ministries/departments of fisheries and voluntary schemes). The use of such schemes for managing environmental impacts of aquaculture is increasing, perhaps because they often tend to be within the purview of sectoral ministries and departments.
- EIA legal requirements are commonly focussed on high value, intensive farming, and particularly shrimp and marine cage farming in tropical areas and marine fish farming in temperate areas. Most legislation is oriented towards farms that cover larger areas, related to potential environmental concerns. Small-scale and inland aquaculture systems are less subject to EIA legislation/regulations. Seaweed and mollusc culture is rarely mentioned in EIA legislation or guidelines.
- Strategic environmental assessment (World Bank, 2008b) is a new concept to the region. As of 2005, only China, Hong Kong SAR, Japan, the Republic of Korea and Viet Nam have legal requirements, to a certain extent, for SEA at national or local levels, or for aquaculture plans. Australia provides one example where environmental assessment is conducted on proposed aquaculture zones in coastal areas, which can be considered a form of SEA. India also conducted an environmental assessment on the shrimp-farming sector. China is also increasing attention on environmental assessment of “special programmes” that can include aquaculture development plans. The legal basis for SEA of aquaculture is increasingly present but there has been limited application of the approach in the aquaculture sector to date.
- Administration of EIA is usually within environmental ministries or departments. In the absence of EIA legislation including reference to aquaculture, the environmental assessment and management of aquaculture usually occurs under a wide range of laws, often with the key ministry of fisheries or equivalent. The need for improved environmental management of aquaculture is recognized widely,

TABLE 1
Summary of EIA legislation and aquaculture across the Asia-Pacific region

Country/state	Aquaculture in EIA legislation	Performed by	Environmental assessment and monitoring functions within government sectoral agency	Aquaculture projects subject to EIA/Scope of EIA requirements
Australia	Yes	Private/ government	Yes	Wide ranging requirements – see Australia country analysis
China	Yes	Private/ government	Yes	Aquaculture in sensitive areas – details not specified
China,Hong Kong SAR	Yes	Private	Yes	Coastal fish farm area > 5 ha, or close to designated sensitive habitats EIA not required for freshwater aquaculture
India	No	Private/ government	Yes	EIA for coastal aquaculture > 40 ha Coastal aquaculture farms >10ha simpler environmental assessment/monitoring required
Indonesia	Yes	Private/ government	Yes	Shrimp/fish ponds > 50 ha Freshwater cage farms > 2.5 ha or 500 units Marine cage farms > 2.5 ha or 1,000 units
Japan	Yes	Private/ government	Yes	Yes
Malaysia	Yes	Private/ government	Yes	EIA for coastal aquaculture project in mangrove wetland >50 ha (>10 ha in State of Sarawak) 10–50 ha require reduced procedures
The Philippines	Yes	Private/ government	Yes	Inland aquaculture – water spread area from 300 m^2 to 10 ha, but depend on environmental sensitivity Coastal areas – yes, but depends on environmental sensitivity
Sri Lanka	Yes	Private/ government	Yes	Aquaculture projects >4 ha in coastal zone Aquaculture projects >1 ha if in mangrove forest All projects if within designated environmentally sensitive area
Thailand	No	Private/ government	Yes	Not specified in general EIA legislation
Viet Nam	Yes	Private/ government	Yes	EIA for coastal aquaculture projects of 10–200 ha, depending on ecosystem (see Viet Nam country analysis) All other projects subject to simpler procedures.

but the regional trend appears to be towards enhanced responsibilities for the sectoral ministries or departments involved with aquaculture. The costs of EIA are in most countries borne by the farm developers, and commonly conducted by hired experts/consultants, with appraisals by government agencies and expert panels. Malaysia provides an example of a country where registered qualified EIA consultants are available for public review on the internet. Authorities in China are also giving more attention to promoting EIA preparation by qualified individuals and firms.

- Decentralisation of government responsibilities, occurring widely across the region, is leading to delegation of some environmental management decisions from central to local government authorities. This process is leading to more administration and decision-making associated with EIA, and more generally the environmental management of aquaculture, at lower administrative levels. This approach raises considerable challenges, due to limited capacity for environmental management at local levels, and sometimes unclear or overlapping legal responsibilities and procedures.
- EIA legislation for aquaculture widely includes reference to EMPs that include environmental monitoring. Environmental monitoring programmes involving aquaculture and the environments where aquaculture is practiced are being more widely conducted, usually under larger government monitoring programmes outside of EIA procedures. Examples can be found in the extensive environmental

monitoring networks for fisheries in China and the developing systems in Viet Nam, both of which involve substantial investment.
- Some general EIA guidelines are now widely available to guide practitioners, but there are fewer focussed on the aquaculture sector. Malaysia provides one example of a guideline for use in aquaculture and Viet Nam has recently developed EIA guidelines for government and aquaculture farmers.
- Voluntary instruments or "soft-law" (such as Codes of Conduct or Good Aquaculture Practices) are increasing in number; some linked to certification schemes and market access requirements. These are operated by governments, and also by some non-governmental organizations (NGOs) or private sector associations. The increasing proliferation of such instruments and certification schemes appears to be in response to market demand, particularly with exported products, and food safety concerns associated with aquaculture products. The scope and content of these documents varies considerably across the region, and there is a need for better harmonisation of content and approaches.
- Public participation and transparency are widely required in EIA legislation, but the requirement is implemented widely in only a few more developed countries/territories (Australia, Japan and China, Hong Kong SAR) within the region. As an example, environmental assessments of coastal aquaculture zones in Australia include widespread opportunities for public participation, leading to extensive public input and sometimes a long period for decision-making.

PRACTICES

Requirements for EIA, environmental monitoring and other sectoral environmental management measures are in place or increasingly being put in place throughout the Asian region. Successful implementation of these measures requires skilled people; access to assessment and monitoring methods, financial and institutional support and monitoring and enforcement powers, amongst others. The availability of such resources across the region has improved significantly over the past decade, but as can be seen from the various country papers, there is still a noticeable lack of capacity and resources for environmental assessment and management of aquaculture. The status of current practices is summarized as follows:
- Legislation is widely in place, but environmental assessment of aquaculture is still practiced unevenly across the region. The scope of most environmental assessment is oriented towards larger scale projects, with limited consideration of small-scale projects, or the cumulative impacts of large numbers of small-scale aquaculture activities. In terms of the wider environmental impacts of aquaculture in Asia, the effectiveness of EIA as a tool for environmental management is therefore reduced, as most aquaculture development in Asia is small-scale.
- Methodologies used and the coverage of major environmental issues in environmental impact assessments in practice is also variable. In many lesser-developed countries, where conducted, the focus is in practice mostly on water and sediment quality, which are more easily analysed and on limited habitat descriptions, with less emphasis on ecological aspects and ecosystem functions. In part, this is a result of limited skills and available methodologies, and limited awareness, resources and capacity for environmental assessment to address the range of environmental issues that may be associated with development of the aquaculture sector. Table 2 provides a further assessment.
- Modelling of carrying capacity and effluent impacts is an important area where the methods are not widely available or skills not in use. In particular, lack of widely available carrying capacity models is noted, although there is increasing interest in development of models relevant to the region's aquaculture. Where available (as seen for example in the Philippines and new models from Indonesia), such models

are only being used on a research basis, and are not yet being applied in project or strategic environmental assessments. Transfer of such methods from research to practical application remains a challenge.

- The use of risk-based methods in environmental impact assessment is limited. Only in Australia (and possibly New Zealand) is risk analysis now starting to be used as a methodology for environmental impact assessment. The wider use of risk-based approaches is recognized as potentially helpful to define more precisely the environmental risks and enabling focus in key issues in environmental management and monitoring (GESAMP, 2008).
- Environmental monitoring of aquaculture areas is now being practiced in several countries across the region, but with widely varied and in some cases inappropriate water quality standards. Widely varied water quality standards are found across the region and some standardisation would be useful. There are some large scale environmental monitoring systems in place in China, and being developed in Viet Nam, intended to provide guidance and "early warning" on water quality trends in fisheries and aquaculture areas. These are mostly funded and operated by government agencies. Environmental monitoring in individual aquaculture projects as a follow up to EIA is practiced to a very limited extent in most countries, with limited feedback to management improvements or project development.
- Environmental monitoring investments, more generally, and specifically as a follow up to EIAs, are in many countries not well connected to management measures. There appears to be limited use of monitoring for improvement of environmental management. Viet Nam provides a case where there has been substantial government investment in environmental monitoring of aquaculture areas; however, the information flow from environmental data collection and link to management remains to be established. China has also made substantial investments in a fishery environmental monitoring system, and is in the process of orienting this towards more monitoring and management of aquaculture farming zones in the coastal areas.
- There is increasing interest and practice in the use of voluntary instruments or "soft law" for management of aquaculture, particularly for exported major commodities such as shrimp. In China, several domestic aquaculture commodities are also now being subjected to certification. These instruments include Codes of Conduct, Codes of Practice (CoP), Good Aquaculture Practices, Better Management Practices (BMPs) and other standards and certification schemes. These approaches are starting to show potential to encourage both environmental improvement and self-monitoring of aquaculture farms. The interest among larger more commercially aware farmers in adopting such standards to gain market advantage is noticeable in some larger shrimp producing countries, such as Thailand.
- Delegation of responsibilities for environmental assessment and management of aquaculture to local authorities under decentralisation policies, such as in the Philippines and Indonesia, brings government managers closer to the farms and has considerable potential to improve environmental management of aquaculture. Potential advantages of this approach is constrained by lack of capacity and financial resources at the local level, as well as lack of clear or complete delegation of responsibilities in others (e.g. the Philippines, Indonesia). Recent guidelines developed in the Philippines (PHILMINAQ, 2006a) provide useful examples to support capacity building at local levels.
- Unclear institutional responsibilities and unclear jurisdictions in practice for environment agencies and sectoral agencies involved with aquaculture are raised as issues in several countries. The need for clearly defined responsibilities is

particularly emphasized in countries devolving responsibilities to local government units, as in Indonesia and the Philippines.

- Review processes and degree of consultation are extremely limited in nearly all countries, except for more developed countries/administrative regions in East Asia and Australia. Involvement of public stakeholders in the EIA process and monitoring varies considerably. Greater involvement of local stakeholders in the environmental assessment process and monitoring has potential to improve effectiveness and reduce costs.
- Impractical or inappropriate environmental management recommendations, which are not affordable or feasible, are also a concern. Whilst it proved difficult to conduct a detailed review of project EIAs and to make generalizations, the need for practical environmental management measures that are affordable and feasible for farmers is recognized as a common constraint in the country papers. This is in part related to the widespread view in the aquaculture industry that EIA is more of an administrative procedure than a management tool to improve environmental (and economic) performance.

The following Table 2 provides an overview of the environmental issues generally considered as important in environmental assessments, and the existing methodology and skills base for the different countries, based on inputs from country reviewers.

TABLE 2
Environmental issues in aquaculture – assessment methods and skills base*

Environmental issue	Assessment methods (potential/in use)	Assessment of skills and knowledge available**								
		Aus	Ch	Ind	Ins	Jap	Mal	Phi	Th	Vie
Environmental plan/policy in aquaculture along whole supply chain	Stakeholder consultations Economic/market analysis Life cycle analysis	4	3	3	2	4	3	3	4	3
Siting and ecological consequences of conversion and changes in natural habitats, such as mangroves, with construction of aquaculture and associated infrastructure	GIS/satellite imagery Site visits/ecological studies Stakeholder consultations	4	4	3	3	4	4	4	4	4
Discharge of pond and cage effluent leading to water pollution and sediment changes and accumulation in farming and coastal areas (including carrying capacity)	Simple water quality models Sediment/benthic impact models Carrying capacity models	4	4	2	3	4	4	4	4 (3)	4
Seepage and discharge of saline pond water that may cause salinity changes in of groundwater and surrounding agricultural land	Water quality modelling GIS/satellite imagery Habitat mapping/ecological studies	4	3	2	3	4	3	3	4	3
Use of fish meal and fish oil in aquaculture diets, collection of trash fish for feeding carnivores	Ecological studies	3	3	2	2	4	3	3	4	3
Environmental and human health risks associated with chemical use in aquaculture	Health risk analysis Analysis of management practices	4	4		3	4	4	4	3	4
Local/trans-boundary movements concerning spread of genetic materials, exotic species and disease	Risk Analysis	4	3	2	3	4	3	3	4	3
Biodiversity issues primarily arising from collection of wild seed, escapes and genetic impacts, and wildlife	Risk analysis (poorly developed)	4	2	2	3	4	2	2	3	2
Socio-economic impacts related to natural resource use for aquaculture.	Stakeholder analysis/ consultations	4	3	3	3	4	3	3	3	3
Voluntary code of practices or environmental management programmes	Benchmarking against key issues above Stakeholder consultations	4	3	3	2	4	3	3	4	3
Monitoring programmes for aquaculture activities	Water and sediment monitoring	4	4	4	2	4	4	4	3	4

* Qualitative assessment from 1 to 4 (1 = limited or no skills; 4 = complete skills easily available). Limited information available for some countries.

** Aus: Australia; Ch: China, P.R.; Ind: India; Ins: Indonesia; Jap: Japan; Mal: Malaysia; Phi: Philippines; Th: Thailand; Vie: Viet Nam.

EFFECTIVENESS

For many countries in the region, the use of formal EIA and monitoring requirements and practices has likely had a limited effect on the wider aspects of management of environmental impacts of aquaculture at the country or regional level. The major reason is that formal EIA tends to be focussed on large scale individual projects, and much of the development of aquaculture in Asia is associated with small-scale aquaculture, often household level farming. There are estimated to be 14 million aquaculture farmers in Asia (Corsin, Funge-Smith and Clausen, 2007), of which the majority are small-scale, making adoption of formal EIA procedures extremely difficult on an individual farm basis.

Thus, although EIA as a tool has provided some environmental benefits at project level, it has not, as practiced, provided significant environmental benefits to the sector. The fast pace of aquaculture development, and some sectors such as shrimp and catfish culture, has also made it difficult for environmental regulatory systems to keep pace. Project-based or sectoral EIA should therefore be seen as one tool in an environmental management strategy for aquaculture, to be combined with other measures for an effective overall approach.

Increasingly, voluntary instruments and “soft law”, linked to market access schemes such as certification, are now being used by governments and some private industry stakeholders to improve environmental performance, building on, or as an alternative to, more formal EIA measures. Emphasis in such schemes is towards high value commodities traded on international markets, where quality, and particularly food safety, are important concerns. There is some evidence that the effectiveness of such voluntary measures, combined with major extension activities, such as in India, has improved environmental performance, but there is a need for wider application. Further assessment of the environmental benefits of voluntary schemes, such as in India, would be useful to guide future approaches.

Some other key points related to the effectiveness of EIA and monitoring include:

- Potential environmental impacts associated with the aquaculture industry are widely known, but awareness of these potential impacts are not always translated into environmental impact assessments or monitoring. Except in the developed countries of the region, where EIAs tend to be comprehensive, the practical scope of EIAs tends to focus on more easily assessed parameters, particularly water and sediment quality and simple habitat assessments.
- In general, the use of data generated by the EIA or ongoing monitoring (by investors, producers, regulators, etc.) beyond the immediate EIA appraisal is extremely limited in most countries. Australia has used the data generated from monitoring to review and improve procedures (such as the benthic monitoring programme for sea cage farms in Tasmania) but such approaches have not been widely used through the region.
- On-farm use of environmental data, generated through formal or informal environmental monitoring procedures, also appears to be limited in most countries. The development and wider use of voluntary instruments has potential to improve effectiveness in use of on-farm monitoring to improve performance. A wider application of such techniques is required to create wider environmental benefits.
- Feedback mechanisms for regular revision and review of the legal requirements for EIA and monitoring procedures and practices exist, and some improvements for aquaculture are being made. Viet Nam is one example where recent reviews of the EIA process have led to change in approaches towards allocating more responsibility to the sectoral agency for environmental management and delegation of environmental assessment, monitoring and overall management responsibilities to local levels. Viet Nam’s EIA guidelines have also provided more focus on practical measures for the small-scale sector, from an earlier version that was oriented only towards large farm areas.

- The general perception of stakeholders (producers, environmental and other NGOs, scientists, etc) about the effectiveness of the requirements is difficult to assess in most countries, without more detailed in-country consultations. The overall "feeling" is that EIA is useful, but it has not always contributed to improved environmental management of the sector, and is viewed more of an administrative burden rather than a management tool. The application to small-scale farms is viewed with particular concern.
- The large numbers of small-scale farmers continue to be left out of most formal environmental impact assessment and management measures, which to date have had limited effectiveness on this important group of the sector. More emphasis on addressing small-scale farmers is needed, perhaps through more widespread promotion and use of strategic environmental assessment and regional or sectoral level planning, and voluntary measures that are inclusive of the small-scale farming sector.

IMPROVEMENTS

There are opportunities for improvements to the environmental impact assessment and monitoring related to aquaculture in the Asian region, and more broadly environmental management in the aquaculture sector. Factors that are important in driving improvements to environmental assessment and management of aquaculture in the region include political will, awareness of the need for and potential positive industry benefits from improved management, investment, capacity and trade/marketing issues. The latter in particular have driven several countries to make significant improvements in environmental management through development and investment in implementation of codes and better practice guidelines, with some demonstrating environmental improvements. The following summarizes some opportunities and recommendations for improvement:

- Strengthening of government legislative systems and clarification of responsibilities for environmental management of aquaculture, both horizontally (between environment and aquaculture sector agencies) and vertically (central to local levels) continues to be needed as aquaculture continues its expansion across the region. Increased designation of responsibilities for management by sectoral agencies can be an effective option for environmental management, as part of an overall management approach for the sector.
- Improvements in environmental assessment related to scale of project, and levels of risk are needed. The single project approach to EIA, only applicable in practice to large-scale projects, should be complemented by assessments at regional or sector level, and related to the degree of environmental risk. SEA legislation is increasingly available, but has seen limited application to aquaculture. SEA has potential for use in addressing the environmental impacts associated with cumulative impacts, or integration of aquaculture with other sectors, or where there are large numbers of small-scale farmers, but capacity and awareness of the approach appears to be limited to date (World Bank, 2008b). Levels of risk should be considered. For example, enclosed freshwaters would be more at risk to water pollution than open marine environments due to less flushing and longer residence.
- Considerable initiatives are being taken across the region to improve environmental performance of aquaculture by sectoral agencies (e.g. department of fisheries) and industry. There has been and is a shift of awareness in government agencies towards the need for better environmental management of the sector, rather than solely promotion of production. This awareness, and associated political will, provides opportunities to introduce improved environmental assessment measures into the process of aquaculture planning and approval where these measures lie outside

of environmental agencies. Sectoral agencies with management responsibilities for aquaculture should be encouraged/supported to adopt more environmental management measures and also encourage development and adoption of codes and other voluntary instruments within the private sector. Regional and international cooperation is also necessary to ensure better harmonisation and improved equivalence arrangements in the use of such instruments.

- Some improvement in environmental data collection is also required. EIAs should be based on real data collected scientifically, not just a theoretical analysis of historical data. Risks of projects from climate change, such as more frequent storms and increasing sea levels also require more attention, particularly at sectoral or planning level.
- The scope and use of environmental monitoring for management should be improved. There are good examples of monitoring programmes for aquaculture areas, for example the environment and disease monitoring system of fisheries and aquaculture in China, and recently established also in Viet Nam. These initiatives can be improved by development of standards and indicators, improved data analysis and creating better links to management. This will require improvements in data collection, handling and processing, and opening up of communication channels vertically and horizontally to responsible government agencies and industry stakeholders. There should be agreed tropical indicators of environmental impact. Efforts in the Philippines are also developing three scales of monitoring survey targeted at small-scale clusters of farms, aquaculture zones and large scale farms that could be reviewed and more widely applied. Roles and responsibilities between private and government also need to be considered.
- The Association of South East Asian Nations (ASEAN) has started the process of standardizing the water quality standards within the Southeast Asian region. This is a very good initiative and should be continued with the standardisation of EIAs for aquaculture farms (scale/scope/methodology, etc) and standardization of environmental monitoring survey methodology, analysis and equipment; although this should in no way compromise the need for flexibility to focus on and address locally important issues.
- Public consultation and information disclosure in many countries is still limited. Improving the EIA and monitoring information/databases and their public availability is necessary.
- There is a need to improve environmental assessment methods and make them widely available. A useful exercise would be to draw together existing guidelines, both general and specific to aquaculture (see reference list), analyse their effectiveness, and make a synthesis widely available. Such a synthesis should bring together practical methods for EIA, but also with emphasis on SEA and environmental management for the small-scale aquaculture farmer. An internet-based “tool kit” for environmental assessment and management measures for aquaculture, with local language material as needed, might also be helpful.
- Carrying capacity models need to be more widely available, tested and suitable models promoted. Calculations in the EIA to assess carrying capacity of the waterbody and the farms should take into account the other farms in the waterbody and not only individual farm projects. A useful summary of existing carrying capacity models for aquaculture is provided in McKinnon (2007).
- Opportunities provided by decentralisation for improvements in local environmental management have not been translated widely into practice because of weak local institutional capacities and sometimes unclear delegation of responsibilities. Such constraints are recognized in the Philippines where recent “better practice” guidelines have been drafted to assist local governments in environmental management of aquaculture, and provide the basis for capacity building. Such

guidelines could be made more widely available and adapted/translated to local circumstances in several countries with decentralised aquaculture management responsibilities.

- There is a need to particularly enhance implementing capacity at local levels, with an emphasis on those countries where decentralization has given more responsibility to local government, but without the necessary implementation skills. Skills for environmental assessment and monitoring, as well as requirements, are different across the region, and there are also good opportunities for sharing of experiences and capacity building among countries, but ultimately investment will be required by countries themselves.
- Use of EIA in aquaculture should be brought to an earlier stage in the project cycle with advocacy of more emphasis on EIA and SEA on aquaculture plans or areas. It is important to encourage and apply strategic assessment for large numbers of small projects. Government investment will likely be necessary for the conduct of such area based SEA initiatives, as is common, for example in Australia. Capacity building and sharing of information on strategic environmental assessment would be one way to promote more widespread testing and adoption of this tool.
- The private sector pays for the conduct of most project-based EIAs, involving mainly larger farms. There is a need to explore means of financial support for the small-scale sector to participate in environmental management schemes, including voluntary schemes.
- Public participation mechanisms, including wider stakeholder involvement in the development of voluntary instruments, should be strengthened to ensure industry ownership and acceptance by the public at large. Transparency in EIA preparation also needs to be complemented by consistency and transparency in evaluation/ appraisal of EIAs.
- The risk analysis approach should be more widely adopted in EIA processes and procedures, to enable focus on key issues and simplified procedures for addressing registration/licensing requirements for large numbers of small farms. Risk analysis can also be used to refine and focus EIA on key issues, and move away from over-simplistic area-based requirements for EIA (e.g. EIA on farms > 50 ha), particularly to target and to focus on key environmental issues related to particular farming systems and locations.
- Much stronger emphasis is also needed on improving environmental management among the small-scale farming sector, through simple regulatory procedures and voluntary measures that support improved environmental management, assisted by improvements in the financial and technical services that will support the transition to better management. Costs associated with such management also need to be carefully considered; as it is unlikely the management costs can and should be absorbed by the small-scale producer.

Country analyses

The following provides a review and analysis of application of EIA and monitoring in aquaculture in selected countries in the Asia-Pacific region. Detailed country analysis studies were developed for Australia, China, India, Indonesia, Japan, the Philippines, Thailand and Viet Nam. Brief descriptions on experiences in other countries/territories of the region are also provided.

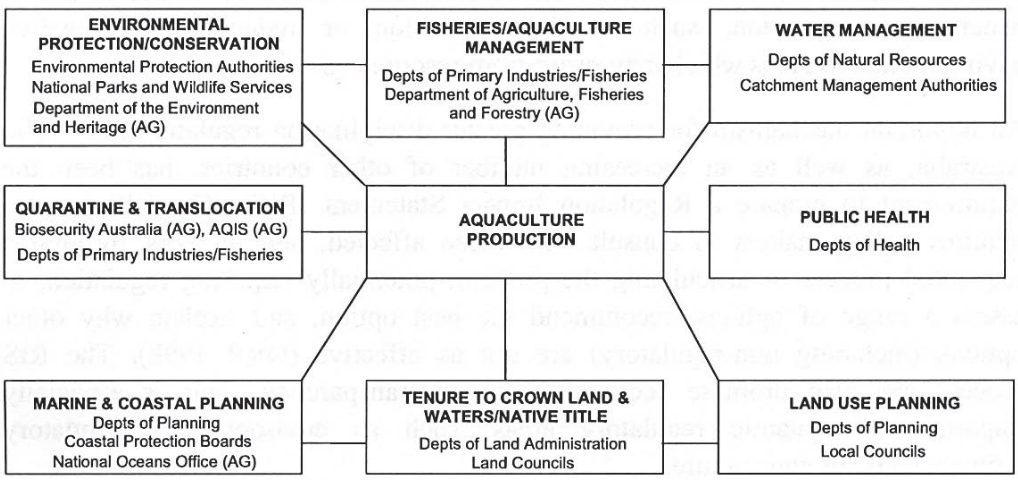
AUSTRALIA[5]

Requirements

Environmental impact assessment

In Australia, investors in aquaculture must comply with a range of federal, state and local government environmental laws to ensure the long-term environmental sustainability of the industry. Figure 1 shows the broad regulatory framework for aquaculture in Australia (after Productivity Commission, 2004). Although there is no over-arching legislation that requires EIA to be carried out on proposed aquaculture developments, the EIA process may be triggered at any level of government depending on the specific nature of the development.

FIGURE 1
The broad regulatory framework for aqusaculture in Australia (after Productivity Commission, 2004)



Note: AG – Federal Department.

<u>*Administration and responsibilities*</u>

The federal government has legislation and regulations to protect matters of national environmental significance, promote ecologically sustainable development (ESD) and ensure standards are maintained in food safety, aquatic animal health, quarantine, trade and taxation (PIMC, 2005). The Environment Protection and Biodiversity Conservation Act, 1999 (EPBC Act) intends to protect the environment and streamline national environmental assessment and approvals processes, protect Australian

[5] Contribution by Fiona Gavine.

biodiversity and integrate the management of important natural and cultural places. An EIA would be required under the EPBC Act if a proposed aquaculture development encroached on areas of National Environmental Significance, National Heritage places and Wetlands of international importance (Ramsar Wetlands). EIA can also be required if the development had a significant impact on the environment in general or the environment of Commonwealth land. There is a standard framework for EIA development and presentation under this Act, but requirements can be tailored on a case by case basis. A policy statement has been developed that gives guidance on when marine offshore developments should be referred under this Act (DEH, 2006).

Proposed developments in or adjacent to, the Great Barrier Reef Marine Park are dealt with by the Great Barrier Reef Marine Park Authority (GBRMPA). Proposals are dealt with on a case-by case basis and an EIA would be required to assess social, environmental and economic issues related to the application.

Individual state and territory governments are primarily responsible for the approval and licensing of aquaculture production within their boundaries. Some states have aquaculture-specific legislation to achieve ESD whereas others use regulations attached to older legislation to ensure ESD, allocation and management of resources, disease notification, access to broodstock or juveniles and compliance with food safety regulations (PIMC, 2005). The regulatory approach also differs where the application involves the use of publicly owned natural resources (such as offshore sites or Crown land) or private land (usually land-based sites). In most states and territories, departments of primary industries (or fisheries), planning, environment and land administration as well as environmental protection authorities administer the regulatory framework and appropriate approvals (Productivity Commission, 2004). Local governments have a role of permitting land-based developments. Table 3 summarizes the responsibilities at federal, state and local level in terms of EIA.

Some states (notably New South Wales (NSW) and Western Australia) require EIA for large-scale aquaculture proposals with potential for significant impacts on the environment (Productivity Commission, 2004), but otherwise EIA is not generally required and an assessment will be made on a case-by-case basis (Table 4).

In Western Australia, the farming of pearls is managed under the provisions of the Pearling Act 1990 and an EIA may be required if the proposal is referred to the Environmental Protection Authority (EPA) for assessment under the Environment Protection Act, 1986 (Everall, 1997). An EIA may be required by the EPA and the

TABLE 3
Summary of responsibilities with respect to EIA

Level of Government	Department	Responsibilities	Public participation and information disclosure
Federal	Department of Environment and Water Resources	Environmental Protection and Biodiversity Conservation Act, 1999	If EIA is required public comment is required on draft before it is finalised. Public enquiry can be requested.
	Great Barrier Reef Marine Park Authority	Great Barrier Reef Marine Park Act, 1975	EIA required.
State	Department of Primary Industries (or Fisheries Agency)	Licensing of aquaculture production (all). Development of regional aquaculture plans for offshore sites. Referral to other agencies as required.	Public consultation required in development of regional plans.
	Environmental Protection Authorities (EPA)	Approval of waste discharges to public waters and setting licence conditions.	
Local	Local Councils	Planning permission required for most land –based developments. Co-ordinates referrals to other agencies. Can request written statement addressing environmental impacts.	Public consultation in planning process.

TABLE 4
State legislation for aquaculture in Australia (Productivity Commission, 2004)

State	Legislation	Responsible Agency	Requirement for EIA
New South Wales	Fisheries Management Act, 1994	NSW Fisheries	Required for large-scale proposals
Queensland	Fisheries Act, 1994	Department of Primary Industries and Fisheries (DPI&F)	Case-by-case basis
	Integrated Planning Act, 1997		
South Australia	Aquaculture Act, 2001	Department of Primary Industries, Resources	Case-by-case basis
Tasmania	Marine Farming Planning Act 1995	Department of Primary Industries Water and Environment	Case-by-case basis
	Living Marine Resources Management Act 1995		
Victoria	Fisheries Act 1995	Fisheries Victoria	Case-by-case basis
	Land Act 1958		
Western Australia	Fish Resources Management Act 1994	Department of Fisheries	Required for large-scale proposals
	Pearling Act 1990		

scope of the EIA must first be defined in an "Environmental Scoping" document that includes:

- regional setting of the proposal (including justification for selection);
- summary of potential environmental impacts, their significance and management responses;
- proposed studies and investigations to be carried out as part of the EIA.

The EIA is then prepared and submitted for assessment and public review prior to approval or otherwise.

Scope of environmental assessment

The scope of environmental assessment required varies between individual states and territories, the production methods employed, the culture environment and the species under culture. Table 5 summarizes some of the issues associated with different production systems in different environments in terms of site, local or off-site impacts.

TABLE 5
Selected potential environmental impacts of aquaculture (Productivity Commission, 2004)

Production system/ species	Potential site impacts	Potential operation – local impacts	Potential operation – off site impacts
Cage culture (marine finfish)	Habitat modification or loss; effects on amenity values	Marine floor degradation; lower water quality; disease; fish escape impact on wild stocks; loss of native wildlife	Disease; fish escapes and impact on wild stocks; cumulative impacts on environment; amenity values
Rack, tray and stick (oysters, mussels)	Habitat modification or loss; effects on amenity values	Marine floor degradation; removal of food for other filter feeders; spread of introduced marine organisms; improved water quality in some areas	Impacts on human health; cumulative impacts on environment; amenity values
Pond culture	Habitat modification or loss; effects on amenity values	Lower water quality; disease; competition with wild stocks; loss of native wildlife	Cumulative impacts on environment; amenity values

Offshore aquaculture

States with significant offshore aquaculture industries (notably Tasmania and South Australia) have statutory marine aquaculture planning with regional aquaculture plans that recommend suitable areas to be allocated for leasing to aquaculture. These plans are developed by the state government and include an EIA of the region and recommend zones suitable for marine aquaculture. In Tasmania, for example, EIAs conducted as part of regional management plans for offshore culture areas collate information on the following topics:

- general characteristics of the area in terms of geography (including climate, winds, geology, rainfall, wildlife habitats), water quality objectives and social and economic description;
- existing uses (shipping, commercial fishing, recreation and conservation);
- suitability of the area for marine farming, including an assessment of potential impacts;
- identification of suitable lease zones and management controls that would relate to these zones;
- once the lease has been allocated for aquaculture development, management controls related to carrying capacity, monitoring and reporting, waste management, disease and other matters are encapsulated into the licence.

The regional plans stipulate general management controls that mitigate negative effects from aquaculture development. These management controls are then incorporated into individual aquaculture licences. When the plans are formalised after a public consultation process, tenders are invited for the leases identified within the plan. Individual licences include environmental conditions to ensure that marine farming operations are sustainable and do not have an unacceptable impact on the marine environment. There is a requirement for baseline studies to be conducted prior to operations commencing and ongoing environmental monitoring.

Victoria and Queensland have also developed statutory planning arrangements recently, whilst Western Australia and NSW have made limited use of statutory planning arrangements, preferring to use EIA to assess individual large-scale developments. Productivity Commission (2004) argues that states not as advanced with planning and implementing marine aquaculture plans may either constrain industry development or lead to *ad hoc* approvals that could result in user conflicts.

Land-based aquaculture

Management of the environmental impacts of land-based aquaculture operations (both coastal and inland) is spread across a number of state agencies (Productivity Commission, 2004). The aquaculture licence granted by the primary industries or fisheries department will incorporate some environmental protection provisions into licences, but operators will also need licences for water diversion, water discharge, works approvals, clearing of vegetation and other activities that impact on the environment (Productivity Commission, 2004). Local councils are responsible for granting development approval and this adds additional layers of complexity, as each council will have a different framework of state planning and development legislation as well as local planning overlays to apply.

The requirement for EIA for land-based sites will be assessed on a case-by-case basis depending on the specific nature and scale of the development. The assessments conducted for inland aquaculture in Australia vary depending on the farming system, management and location of the proposed development. The assessment approach and associated monitoring requirements vary from state to state. In Queensland, when an aquaculture development is deemed to be “low impact”, it is designated a “self-assessable” development and may be carried out without a separate approval from the DPI&F (DPI&F, 2005). The main criteria that determine a development to be “low impact” are (see DPI&F, 2005 for specific details):

- there is no discharge of waste to Queensland waters;
- the species is an indigenous freshwater fish, and;
  - is carried out in ponds or tanks with a total surface area less than 5 ha;
  - is for aquarium display or human consumption only;
  - is a part of an enclosed system no more that 50 m^2 in area;
  - is outside an area prescribed under the Fisheries Act 1994 as an area from which the fish may be released.

In contrast, aquaculture activities that are considered “high risk” and require specific management arrangements include (DPI&F, 2004):

- aquaculture on potentially flood-prone land;
- aquaculture of species that are non-indigenous to the area;
- use of aquaculture product for bait.

In South Australia, the government recognizes “(1) the diversity of the land-based aquaculture industry, (2) the need for an environmental risk profile classification system and (3) the need to vary EMP and reporting requirements of land-based licenses accordingly”. This “risk-based approach” to assessment is used to allow management and monitoring to be focused on key environmental concerns. Land-based licenses in South Australia are classified into three categories of environmental risk profile; low, medium and high depending on (1) the manner in which water is discharged and (2) the amount of feed input. The classification against environmental risk is noted in Table 6.

TABLE 6
Classification of environmental risk profile for land based aquaculture operations based on discharge type and feed usage (Discharge type - “controlled” = some treatment; uncontrolled = no treatment. Feed type – minor manufactured = limited feed use; major manufactured = intensive feed farming)

	Discharge type		
Feed type	None	Controlled	Uncontrolled
Natural	Low	Low	Low
Minor manufactured	Low	Low	Medium
Major manufactured	Low	Medium	High

In NSW inland aquaculture licences are classified according to the intensity of production whereas in Victoria, licences as classified according to species and specific guidelines have been developed to address “high risk” proposals such as barramundi culture (DNRE, 2002).

The type of production system proposed will have a bearing on the level of resource use and potential impacts on the environment. Systems range from flow-through culture systems (e.g. intensive trout farming) to static pond systems (used in native fish production) to fully enclosed re-circulating aquaculture systems (RAS). Flow-through or “open” culture systems have the highest degree of interaction with natural resources to provide inputs (such as water and dissolved oxygen) and remove wastes from the system. In general, such systems require a higher level of scrutiny in terms of their impact on the environment than “closed” or “semi-closed” systems, although the disposal of wastes which accumulate within closed or semi-closed systems must always be accounted. Flow-through intensive systems are commonly used for the production of salmonids in Victoria and South Australia and would be classified as a “high” risk operation according to Table 6. Although a formal EIA is not generally required in Victoria, prior to development the proponent must submit a range of information (Table 7) to the following agencies (in addition to that required by Fisheries Victoria for their aquaculture licence).

Voluntary instruments

Most sectors of the aquaculture industry have developed codes of practice to standardise environmental operations in their industry. Table 8 shows some of the codes of practice and other voluntary instruments available.

Environmental monitoring

Environmental monitoring requirements for aquaculture in Australia depend on state requirements, species cultured, site characteristics and the culture environment (marine or freshwater).

TABLE 7
Environmental information required for various licenses for salmonid farms in Victoria

Agency	Licence	Environmental data required
Water Authority	Water diversion license	• daily flow requirements; • low flow frequency in the waterway; • type of proposed diversion works and outfall works; • flow monitoring proposals; • operating arrangements; • distance between diversion and discharge points; • existing water quality and impacts of the proposal.
Catchment Management Authority (CMA)	Waterways work permit	
EPA	Discharge licence	• average monthly and daily flow distribution within the waterway; • minimum mean daily flow distribution within the waterway; • nutrient concentrations in discharge water; • minimum, monthly and average effluent dilution calculations.
Local authority	Planning permission	• existing vegetation and landscape of the site; • listed flora and fauna; • sites of cultural heritage significance and any other notable features of the site.

TABLE 8
Voluntary instruments

Sector	Name of document	Reference
Tuna	Tuna code of practice	
Prawns	Australian prawn farming manual	Robertson, 2006 DPI&F, 2006
Salmonids (inland)	Best Practice Environmental Management Guidelines for the Victorian salmonid aquaculture industry	Gavine *et al.*, 2006
Recirculating Aquaculture System	Best Practice Environmental Management Guidelines for Recirculating Aquaculture Systems in Victoria	Gavine *et al.* (in press)

Offshore aquaculture

Environmental monitoring is widely conducted in marine aquaculture in Australia. The actual practice depends on state requirements, species cultured, site characteristics and issues identified during the EIA. A summary of environmental monitoring requirements for selected marine production systems is shown in Table 9. In Victoria, the leaseholder may not be the same as the aquaculture licence holder. In Tasmania salmon culture, once the development has been approved, individual leaseholders are required to undertake baseline assessments. This is a one-off survey undertaken prior to production commencing and if there is a relocation or expansion of lease area by more than 10 percent. Ongoing monitoring is also required for offshore salmon farms. For each lease a video survey must be carried out every six months and a more detailed survey every two years (Table 9). Shellfish farms do not require ongoing monitoring as research has shown that impacts are not significant (Crawford, 2003). Other states, however, do have a requirement for ongoing monitoring of shellfish farms (e.g. Victoria).

Inland aquaculture

The type and level of environmental monitoring programmes and reporting requirements will vary depending on the risk classification from the assessment phase in some states. The environmental monitoring programmes are then developed based on the degree of risk, with higher risk farms requiring additional parameters of increased frequency of sampling. Table 10 provides an example of the frequency of water sampling required for farms with different degrees of environmental risk.

TABLE 9
Summary of environmental monitoring requirements for marine aquaculture by different states (adapted from Crawford, 2003; the asterisk denotes activities to be carried out by the leaseholder)

	South Australia		Tasmania		Victoria	
	Tuna Baseline	**Tuna Ongoing**	**Salmon Baseline (cages)**	**Salmon (ongoing biennial)**	**Mussels Baseline**	**Mussels (ongoing yearly**
Current flow			√		√*	
Bathymetry			√		√*	
Habitat profile			√		√	
Video survey	√		√	√ (six monthly)	√	√
Sediment chemistry						
Redox			√	√	√	
Particle size			√	√	√	
Organic matter			√	√	√	
Stable isotopes			√		√	
Benthic infaunal analysis					√	
Family id		√a	√	√	√	

a/ Not required at this stage

TABLE 10
Frequency of water quality sampling against degree of risk

Risk profile	Monitoring per year
Low	0
Medium	1
High	3

Environmental sampling results are reported to the regulatory authority, and in the case of non-compliance further action may be taken.

In inland aquaculture, there are further differences in requirements by the state. In South Australia, the diversity of aquaculture systems is recognized and monitoring requirements defined based on an assessment of environmental risk, with monitoring developed based on the degree of risk, with higher risk farms requiring additional parameters of increased frequency of sampling. Table 11 provides an overview of requirements by system.

TABLE 11
Summary of environmental monitoring requirements for inland aquaculture by system

	Flow through systems in Victoria	RAS	Static pond
Water quality	√	√	
Water flow	√		
Feed inputs	√		

Practices

This section considers and analyses the practices applied for EIA and environmental monitoring and difficulties and constraints in implementing such EIA studies and recurrent environmental monitoring efforts.

Environmental assessment methods

In both offshore and land-based aquaculture, environmental standards that the farmer must comply with are incorporated into the relevant licences. The farmers are then required to carry out monitoring of their operations and report back to the regulating agency on a periodic basis.

Offshore aquaculture

Environmental standards that are commonly included in Tasmania salmon aquaculture licences are related to unacceptable impacts on sediment quality and the water column. Licence conditions specific to benthic impacts include (DPIWE, 2004):

- no unacceptable visual, chemical or biological impacts on the benthos 35 m beyond the boundaries of the lease. A variety of standards are given that define unacceptable impacts;
- presence of feed pellets;
- mats of *Beggiatoa* sp;
- increase in organic carbon content of more than three times the levels at the control site;
- negative redox levels 150 mV less than the control site;
- presence of numerous opportunistic polychaetes on the sediment surface;
- fallowed areas should not be restocked until visual evidence shows the sediment surface is free from *Beggiatoa* sp. mats.

Where a significant visual impact is detected outside the boundary a more intensive environmental survey may be triggered. The quality of the water column surrounding the lease area should comply with the standards designated in the licence. In terms of reporting, the farmer is required to provide reports on the following:

- significant incidents of disease and/or fish kills;
- marine pests;
- significant out-gassing from the sediments;
- environmental monitoring.

In Victoria, mussel farmers must provide a video of the substrate of the lease area on an annual basis. Triggers for management intervention are the presence of mats of *Beggiatoa* sp., organic accumulation and/ or the presence of debris.

In South Australia, tuna farmers must comply with an environmental monitoring programme and report annually on the following items:

- description and layout of the site;
- site fallowing plan;
- stocking density, biomass held and mortalities for each sea cage per month;
- amount and type of feed used per month;
- development history for the reporting period;
- comparison of benthic infaunal communities between potentially impacted and control sites;
- interactions with large marine vertebrates;
- details of any disease incidents and chemicals and/or medicines used.

Land-based farms

In Victoria, where intensive flow through culture (classified as "high" risk) is commonly used for the production of salmonids a major concern is the potential impact of wastes discharged on the "beneficial uses" of a waterway. "Beneficial uses" for particular types of waterway are protected under the State Environmental Protection Policy (Waters of Victoria), which also sets water quality objectives for particular segments of the environment (e.g. highlands, coastal plains, etc). Proponents of new and expanding salmonid farms must ensure that their farming activities do not compromise "beneficial uses" reliant on the quality of water, particularly those posed by inputs of nutrients, pathogens and aquatic pests. An Environmental Protection Agency (EPA) licence is required to discharge wastes to the aquatic environment. Compliance with licence conditions will ensure that the impacts of discharges are minimized to protect the beneficial uses of receiving waters.

To comply with the requirements of a Victorian EPA discharge licence, a salmonid aquaculture farmer is required to:

- monitor water flow and quality through the farm as well as other waste streams, their volume and management;
- provide a plan for environmental improvement;

- undertake annual reviews of the operation and submit an annual report, including progress towards environmental objectives;
- notify the EPA of all major events that may impact on the quality of wastewater leaving the property or the overall operation of the farm.

Each year the license holder must submit a report to the EPA that contains the following information:

- explanation of any failure to comply with licence and steps to remedy;
- monitoring results from previous 12 months;
- a "mass-balance" of production for the past year that includes, total biomass of fish, harvested tonnage, total mass of fish feed (and brand name);
- phosphorus (P) and nitrogen (N) balance for the site; N and P in from river; N and P added in feed, N and P harvested from ponds;
- any complaints received and enforcement action by EPA;
- report on the implementation of the environment improvement plan (EIP);
- interpretation and analysis of monitoring data.

Aquaculture developments with a lower risk classification have less stringent monitoring and reporting requirements. Indeed, if they do not discharge to public waters, there is no need for a discharge licence from the EPA.

Monitoring methods

<u>*Offshore culture*</u>

Methods currently used for baseline and ongoing monitoring in Australia (e.g. Tasmania) are shown in Table 12.

TABLE 12
Monitoring methods used offshore aquaculture in Tasmania

	Method of assessment	Reporting
Current flow	Speed and direction at 30 minute intervals continuously over a six week period at one site in the lease area. Current meter located 2 m above the bottom and accurate to 5 percent, minimum level of detection 2.5 cm/s.	Data presented graphically to standard format.
Bathymetry	Depth measured every 100 m throughout lease area and 50 m beyond using boat with echo sounder and log measuring distance.	Contours drawn on lease area map.
Habitat profile	Location of habitat types must be identified by diver, sonar or video survey.	Sketch on map of lease area.
Video	Video at pre-determined locations. Transect-line to be placed on sea bed at 90° to the lease boundary at the locations.	Written diver notes to be supplied with video tape.
Sediment chemistry	Three undisturbed cores taken using Craib Corer with 50 mm diameter perspex core. Note length of core, colour, plant and animal life, gas vesicles and smell.	Written description required
Redox	Made at sediment-water interface, 1 cm below surface and 4 cm below.	Report results in mV.
Particle size	Top 100 mm of core sub-sampled. Wet sieve method.	Data in excel spreadsheet.
Organic matter and stable isotopes	Top 3 cm core oven dried at 60 °C prior to analysis of total organic carbon (loss on ignition method). Stable isotope analysis done using mass spectometry.	Data forms part of report.
Benthic infaunal analysis	Van Veen grab or core samples taken at fixed points along the video transect. Samples sieved through 1mm sieve all organisms identified to family level and counted	Original data with K-dominance curves.

<u>*Land-based farms*</u>

In the case of land-based flow through trout farms in Victoria, Table 13 shows the water quality parameters that need to be monitored six times per year at licensed farms.

<u>*Personnel and costs*</u>

Costs of environmental assessment and implementation of ongoing environmental management programmes, including monitoring, are borne by the aquaculture farmer. The cost of compliance is noted in Table 14.

TABLE 13
Monitoring methods for "high risk" inland aquaculture in Australia

	Unit	Median	Maximum	Monitoring frequency (per months or year)	Analysis
Non-filterable residue (suspended solids)	Mg/l	5	10	6	Conducted by a nationally accredited laboratory using standard methods
Total phosphorus	Mg/l	0.1	0.2	6	
Total ammonia	Mg/l	0.3	0.4	6	
Dissolved oxygen	Mg/l	Not less than 6.0	≥8.0 or 70 percent	6	
Temperature	°C	No standard but must be reported		6	
pH	Units	6.4–7.7		Annually	

TABLE 14
Estimated costs of compliance with baseline and ongoing monitoring in marine offshore leases (average of costs supplied by several consultants)

	Baseline survey	Six monthly video survey	Biennial survey	Reference
Tasmania	$A17 000	$A5 000	$A15 000	DPIWE (2004)

Costs of compliance for "high" risk inland aquaculture is made up of hydrological monitoring and reporting ($A3 500 per farm per year) and water quality analysis ($A3 000).

Difficulties and constraints in practice

In the marine environment, the requirement for monitoring and reporting has been in place for many years. In Tasmania, an industry-wide benthic monitoring programme has been operating since 1997, which ensures that the practices are consistent across the industry.

The current one-size fits all approach to regulating discharge from flow-through salmonid farms in Victoria does not take into account the risk associated with individual farms. Currently ongoing research suggests the need to develop a risk-based approach to ongoing monitoring.

Effectiveness

Technical appropriateness

Offshore aquaculture

The development of environmental management procedures for offshore aquaculture in Australia has benefited from the experience of other countries. Management controls and monitoring requirements for Atlantic salmon culture in Tasmania were derived originally from the results of extensive R&D studies carried out in Europe, notably Scotland and Ireland (Crawford, 2003). They are also consistent with the recommendations of the GESAMP Expert Working Group on Environmental Impacts of Coastal Aquaculture (GESAMP, 1996). They are highly appropriate for monitoring the impact of offshore salmonid aquaculture.

Tasmania has reviewed the data from its industry-wide benthic monitoring programme that has been in operation since 1997 (DPIWE, 2004). The benthic monitoring programme has enabled the compilation of a comprehensive, area-specific dataset, providing information on environmental conditions within marine farming lease areas, at compliance and control sites. Baseline environmental assessments of finfish lease areas in Tasmania indicated that the majority of lease sites:

- experience low current flows (average 3.34 cm s^{-1}) that are often tidally driven, although at times weather conditions appear to significantly influence regional hydrodynamics;

- operate in a depth range of 14–25 metres with a mean depth of 18.6 m;
- operate over muddy/silty sediments devoid of any significant vegetative cover. Small patches of intermittent algae, seagrass and unconsolidated reef were identified within several lease areas.

The review has also indicated changes to the environmental monitoring programme that will simplify monitoring requirements for some farms.

Land-based aquaculture

Current EPA discharge licences require that "high" risk salmonid farmers monitor effluent quality through "spot" sampling of inlet and outlet water. However, the large seasonal variations in waste outputs can render compliance sampling on the basis of spot samples inadequate (Gavine *et al.*, 2006). Natural variations in the inflow water and time required for water passage through a farm also creates a complex relationship that is not easy to resolve. In addition, improvements in farm performance are difficult to pick up in discrete sampling programmes. For this reason, the EPA has moved to the use of feed and production auditing and the application of nutrient mass-balance models to assess the performance of the farm. Mass balance modelling and periodic surveillance of water quality represents best-practice for intensive trout farms (Gavine *et al.,* 2006).

Use of data for improved performance of aquaculture

In general, the data generated from monitoring is used by government and industry to improve environmental performance of the sector.

Impact of EIA and monitoring on environmental protection

The EIA process and monitoring is seen as a part of the environmental management measures and is subject to regular review and change to improve the overall process of environmental protection. The intensive offshore culture of finfish expanded rapidly in South Australian and Tasmanian waters (or coasts) in the late 1980s and early 1990s before appropriate regulations had been developed to manage the environmental (and other) consequences of that expansion. The expansion of the industry was accompanied by increasing public concern about equity in the planning and allocation of waters for aquaculture and about the potential for environmental and visual pollution and navigation conflicts (Everall, 1997). The development of aquaculture-specific legislation that allowed pro-active planning for the industry has gone a long way to addressing public concerns and improving the environmental performance of the industry.

The success of the monitoring programme at land-based sites in protecting the beneficial uses of the river system is largely unknown due to a lack of contemporary data on the impact of these farms on the downstream environment. There is currently a research project underway to investigate this and develop a risk-based approach to the monitoring of land-based farms.

Feedback and review

The application of EIA and environmental management measures in general are subject to regular review in Australia, leading to various changes and developments in recent years.

In Tasmania, the effectiveness of the industry-wide programme in terms of detecting unacceptable impacts was recently reviewed (DPIWE, 2004). That review concluded that:

- there had been localised impacts but no detectable unacceptable deterioration;
- the monitoring programme has proven to be an effective tool for managing the environmental performance of the finfish industry;

- the monitoring programme requires review and adaptation for improved outcomes.

Perceptions of stakeholders
No perceptions of stakeholders were obtained during this review.

Improvements
Regulatory and legislative aspects
At a national level questions have been raised about whether the current environmental regulatory arrangements for aquaculture are appropriate (Productivity Commission, 2004). That is whether production is constrained in some states due to lack of access to suitable sites, tenure and the complexity and number of lease and licence requirements. A "Best Practice" framework of regulatory arrangements for aquaculture in Australia has recently been endorsed by the Primary Industries Ministerial Council (PIMC, 2005). This framework was based on a detailed review of regulatory arrangements for Australian aquaculture (Productivity Commission, 2004) and aimed to achieve a high level of integration across the three (vertical) levels of government involved in the planning and approval process. The recommendations of the "Best Practice" framework were as follows (PIMC, 2005):

- integration of policy and clear legislative objectives – the overall objective and responsibility for aquaculture in each jurisdiction needs to be clarified as does the role of relevant agencies and the inter-relationship between aquaculture and other planning and environmental instruments;
- regional planning in line with appropriate planning and land-use principles – plan for aquaculture in a pro-active and integrated manner to provide confidence and clarity to industry, government and the community;
- zoning for aquaculture – areas considered appropriate for aquaculture development should be zoned using planning instruments;
- transparent and equitable allocation of marine and freshwater resources for aquaculture;
- leasing – investors need security of tenure;
- risk assessment and management strategies commensurate with the level of risk (see technical and scientific aspects below);
- development consent processes – need to be aligned with other development processes;
- licensing – should be more adaptive in nature, need for national approach;
- compliance – licence conditions must be clear and enforceable;
- environmental management systems (EMS) and eco-efficiency – important for enhancing "clean and green" image of Australia.

Technical and scientific aspects
There is a general move to an adaptive or risk-based approach to environmental management in both offshore and land-based sectors. The review of monitoring data from 1997–2002 showed that the current monitoring regime was working well (DPIWE, 2004). DPIWE wants to move to a more adaptive style of management that recognizes the conclusions of the R&D and monitoring programme as well as the environmental credentials that companies have built up over the years and the specific risk associated with some sites. The proposed new programme is designed to rely predominantly on video evidence to detect unacceptable impacts. Where unacceptable impacts are found, a comprehensive benthic survey would be triggered to determine the extent of the impact. An adaptive management approach significantly reduces compliance costs for farmers in Tasmania (DPIWE, 2004). In inland aquaculture, most states already implement some form of risk assessment prior to granting licences. This determines the level of monitoring that is appropriate for developments.

Collaboration
The move towards adaptive management has been largely a result of collaboration between industry and regulatory authorities – an example of building trust through working together.

CHINA[6]

Requirements

Environmental impact assessment
EIA was first formally applied in China (Gu and Sheate, 2005) for construction projects in 1979 when the Environmental Protection Law (Trial) was enacted, and there have been various legal and policy developments since that time. In 1981, the State Council Environmental Protection Commission issued an administrative order for the Guidelines of Environmental Management for Construction Projects for the implementation of EIA that required an environmental impact statement prepared for new or extension of projects with potential for pollution. Further amendments to the law and guidelines were made in 1981, 1986 and 1998. A new EIA law, The Law of the People's Republic of China on Environmental Impact Assessment (China, 2006-2007) came into force in 2003. Under the EIA Law, EIA is defined as a system for (1) analysing, forecasting and assessing the potential impact on the environment after implementation of planning and construction projects, (2) establishing strategies and measures to prevent or alleviate adverse impacts on the environment and (3) implementing follow-up reviews and monitoring.

The EIA Law requires a project developer/owner to submit an "EIA document" to the State Environmental Protection Administration (SEPA) or its local counterpart before commencing construction of any project in China. "EIA documents" are classified into three categories depending on the level of a construction project's potential environmental impact:

- Where the potential impact is "significant", the developer must prepare an environmental impact report (EI Report) containing a comprehensive assessment of the resulting environmental impact.
- Where the potential impact is "light", the developer must fill out an environmental impact report form (EI Form) containing an analysis or special assessment of certain aspects of the resulting environmental impact.
- Where the potential impact is "very light", the developer may simply file an environmental registration form, and assembly of an EIA is not required.

SEPA formulated and published the EIA Classification Catalogue, which provides a reference to determine what type of EIA documents are required for a particular construction project, including large-scale aquaculture projects.

EIA requirements in China have focused mainly on construction and large-scale development projects but the Environmental Impact Assessment Law of 2002 expanded EIA requirements from individual construction projects to government plans for the development of "relevant special programmes" of agriculture, animal husbandry, forestry, water conservation and natural resources, amongst others, which includes aquaculture (Stender, Wang and Zhou, 2003; FAO, 2004-2008, NALO China; Radosevich, 2002). It also includes reference to environmental assessment of plans for utilization of water and land areas, and has expanded the scope of environmental assessment to use of strategic environmental assessment (Tao Tang *et al.*, 2005).

A "Planning Environmental Impact Assessment" regulation (EIA) draft was available for comment in April 2008, and is expected to be officially released during 2008. The purpose is to provide more guidance on strategic environmental assessment,

[6] Contribution by Fan Enyuan.

and to bring environmental assessment earlier into the decision making process. The application of this approach to aquaculture development in coastal or inland areas is uncertain.

The recent changes in EIA requirements for aquaculture in China, with the latest requirements, are summarized in Table 15.

TABLE 15
EIA requirements for aquaculture in China

EIA requirements	1999		2002		2008	
	Freshwater	Marine	Freshwater	Marine	Freshwater	Marine
EIA report	Not clearly listed	Not clearly listed	Not clearly listed	Projects with 133.3 ha and above in enclosed coastal area	Cage aquaculture and net enclosure aquaculture in sensitive area	
EIA form	Not clearly listed	Not clearly listed	Aquaculture in lakes	Projects with 13.3 ha and above in littoral areas higher than the highest tidemark; projects with 66.7 ha and above littoral areas between the highest and the lowest tidemark; projects with 333.3 ha and above in some open coast area.	Other types of aquaculture in sensitive area	
Environmental registry form	Not clearly listed	Not clearly listed	Other types of aquaculture	Other types of aquaculture in sensitive area	Not clearly listed	
Validity	Invalid		Invalid (valid from 1 January 2003)		In effect (valid on 1 October,2008)	
1.EIA classification catalogue, The State Environmental Protection Administration (SEPA), 1999						
2.EIA classification catalogue, The State Environmental Protection Administration (SEPA), 2002						
3.EIA classification catalogue, Ministry of Environment Protection (MEP), 2008						

Environmental assessment and aquaculture

Environmental assessment and management of aquaculture, in the broadest sense, is conducted within the framework of various laws and different levels in China:

1. sectoral and regional planning;
2. project development and management;
3. market and aquaculture product quality control level.

The planning and project level may both involve assessment under the national EIA law, but environmental assessment and management procedures are also related to various other legislation applied in China, including the Fishery Law, Marine Environmental Protection Law and others. The market "product level" is increasingly given attention in China to improve the quality and safety of aquatic products, and legislation has been promulgated and implemented recently to address environment-related management issues at this level, including monitoring and management of contaminants of aquaculture products caused from water pollution arising by other sectors.

Administration and responsibilities

EIA and environmental protection agencies

The institutional arrangement for EIA is closely related to the overall institutional structure for environmental protection in China, which reflects a decentralized structure of political and financial administration. The country is administered on a five-tier government structure: central, provincial (autonomous regions and municipalities under direct control of the central government), municipal/prefectural, district/county and town/township governments. Each level of local government is responsible for development and administrative matters in their respective jurisdictions.

The environmental competent authority (SEPA) under the State Council is responsible for national environmental protection in the implementation of integrated supervision and management. Environmental competent authorities in the governments at county level and above are responsible for the environmental protection in their respective jurisdictions. These responsibilities for environmental protection are defined by the 1979 Environmental Protection Law.

The highest national authority for environmental protection is the State Environmental Protection Administration (SEPA), a ministry elevated from a quasi-ministry of the National Environmental Protection Agency (NEPA) in 1998 directly under the State Council. SEPA is responsible for drafting and interpretation of standards, laws and regulations and guidelines, and supervision and inspection of their implementation. SEPA is involved in review and approval of environmental assessment reports for larger projects, such as those with budget funds from the central government and designated as budgetary investment projects, projects dedicated with special funds, nuclear projects, confidential projects and military industrial projects, as well as those cutting across regions or river basins. For other projects requiring only an EIA reporting sheet or EI registration, the documentation will be reviewed and approved, under the authority of SEPA, by the Environmental Protection Bureau (EPB) institutions of the provinces, autonomous regions or municipalities where the construction projects are to be implemented.

At the local government level, the basic structure for environmental authorities from provincial to district/county levels is similar to the national government. The competent authority for environmental protection at each level is the EPB, which conducts supervision and management in their respective jurisdictions. Other departments with some environmental protection responsibilities at the same level of government manage pollution or resource issues in their respective sectors and are supposed to collaborate with the environmental competent authority in environmental supervision and management. Provincial level EPBs focus mainly on macro issues such as policy, regulation and guidance, while district/county EPBs carry out detailed supervision and management tasks. Municipal EPBs have both macro and micro-responsibilities for supervision, management and enforcement, and especially have direct contacts with large enterprises. The relationships between different levels of environmental authorities and between EPBs and other government authorities are structured in vertical and horizontal dimensions. An EPB belongs to two distinct government units. It is vertically part of a chain of the environmental protection functional line from the national environmental authority of SEPA through provincial, municipal, to district/county EPBs and receives policy mandates and programme direction from the upper-level EPB. At the same time, it is horizontally also one of the departments in a local government and relies heavily on that local government for financial support.

SEPA is complemented in its role by other ministries that also have responsibilities touching on environmental protection. They include the ministries of planning and development, economic, trade, urban and rural construction, water resources, agriculture and forestry and transportation. Environmental matters relating to aquaculture and fisheries are considered within the Ministry of Agriculture, and particularly under the Bureau of Fisheries.

In addition to the government authorities, quasi-government institutions such as research and educational institutions play an important role in environmental protection within the overall institutional framework. In the environmental field, an EPB usually has affiliated institutions such as environmental supervision and fee collection offices, environmental monitoring centres and stations and environmental research institutes.

An Environmental Impact (EI) Report or an EI Form must be prepared and issued by an EIA agency certified by SEPA. As of August 2005, China had a total of 973 qualified EIA agencies, among which four are foreign-invested and ten are privately-owned. The majority of qualified EIA agencies are state-owned enterprises, research arms of universities and research institutions (Paul *et al.*, 2006).

The administration of aquaculture, and the environmental management aspects of aquaculture development in inland and coastal waters, also involves various government agencies operating at various levels.

Ministry of Agriculture

The Ministry of Agriculture (MoA) is the highest administrative body in charge of the national fishery industry. Empowered by the State Council, the ministry is responsible for administration of the rural economy, including plant production, animal husbandry, fishery, rural township and village-run enterprises, fodder industry and farm machinery and others. The Bureau of Fisheries (Bureau of Fisheries Management and Fishing Port Superintendence), falling under the MoA, is the main administrative body governing the fisheries and aquaculture sector. The major functions assigned to the Bureau are:

- formulating fishery law and regulations, and inspecting implementation;
- making fisheries development policies, strategies and plans, instructing fishery economic and business system reform;
- administration of the nation's processing and marketing of aquatic products, including setting aquatic product quality standards and enforcing them;
- being responsible for national fishery statistics, resources management and rare aquatic wildlife protection.

As in the case of the environmental administration, there are fishery bureaus in the provinces, autonomous regions, municipalities and counties, which have more or less the same functions as the Bureau of Fisheries in their respective geographical and administrative areas.

According to the permitting process for the Fisheries Law and it's implementing regulation, the People's Governments at or above the county level may grant licenses to use state-owned water surfaces and tidal flats to state and collectively owned units to develop aquaculture. The granting of licenses for aquaculture in "planned" coastal areas involves increasing attention to environmental issues, with restrictions on use of fishery habitats and sensitive ecosystems for aquaculture.

Ministry of Land and Resources

The responsibilities of the Ministry of Land and Resources (MoLR) include planning, administrating, protecting and regulating utilization of natural resources such as land, mineral and marine resources (with the exception of marine fishery resources managed by the MoA).

The State Oceanic Administration (SOA) is an administrative agency under the MoLR responsible for the supervision and management of sea area uses and marine environmental protection, as well as safeguarding national maritime rights and interests according to laws and regulations, and organizing and carrying out marine scientific and technical research. SOA is the main administrative body with responsibilities that also relate to the interactions between marine aquaculture and the marine environment.

A number of other ministries, and related institutes and departments at central and lower level administrations also influence, in various ways, the accessing of land and water resources for aquaculture development as discussed further below.

Legislation

Apart from the Environmental Protection Law referred to above, other important national laws relate to the environmental assessment and management of aquaculture in inland and coastal waters. There are also some local (provincial and river basin-wide) regulations that may be applicable to environmental impact assessment. Amongst the various national laws, the following are considered particularly significant for aquaculture. Further information can be found in the FAO National Aquaculture Legislation Overview for China (FAO, 2004-2008, NALO China).

Fishery Law

The Fishery Law, amended most recently in 2004, is a basic law dealing with fishery management including aquaculture, fishing and fishery resource enhancement, utilization and conservation. The scope of the law includes improving the management of fishery resources, development of the aquaculture and fishing industry and enforcement measures over fishing and aquaculture resources.

The Fishery Law provides a basis for provision of aquaculture licenses. The state is responsible for drawing up plans for the use of water surface areas and defining those areas of water surface and intertidal zone or mudflats suitable for aquaculture purposes. Units or individuals, who wish to use those designated areas, must apply for an aquaculture permit through the competent fisheries administration at or above the county level, and the aquaculture permit will be granted by government at the same level to allow use of the area for aquaculture. The aquaculture licence may also be withdrawn if the individuals or units do not use the designated area within a 12 month period. The zoning of areas for coastal aquaculture, required under the law, is seen as an important tool for environmental management of aquaculture in coastal areas, although capacity for effective planning and management of aquaculture zones varies between local administrations.

The law also has provision for environmental protection during the permitting process, as aquaculture is allowed only in designated areas, and it specifically states that natural spawning, breeding and feeding grounds of fish, shrimp, crab, shellfish and algae in state owned water surfaces and tidal flats as well as their major migration passages cannot be used for siting of aquaculture farms.

Land Administration Law

The use of state-owned and collectively owned land is regulated under the Land Administration Law (1986, as amended in 2004), and deals with land ownership, use and planning issues. It requires the state to formulate an overall plan for land utilization, classifying land into agricultural land (including aquaculture), construction land and unused land. Although the law reaffirms the principle of state/collective ownership of land, it incorporates significant moves towards stronger and more secure individual rights in land used for farming, forestry, livestock and fishery production, in particular where it concerns rights of individual cultivators who make up a collective. The law provides for farmer contracts of 30 years, thus giving the individual formal rights over an area.

Water Administration Law

The Water Law (1988, as amended in 2002), administered by the Ministry of Water Resources (MoWR), regulates the development, utilization, saving, protection, allocation and management of water resources. All water resources are owned by the state. The law requires the state to implement a system of water withdrawal permits and paid use of water resources. In the development and utilization of water resources, domestic water for urban and rural use has first priority, and then other uses should be taken into account. Although the law does not contain any direct reference to aquaculture, the establishment of water conservation facilities, particularly the establishment, utilization and management of water reservoirs will play an important part in fishery production, in particular in freshwater aquaculture development.

Law on the Administration of Sea Areas
The Law of the People's Republic of China on the Administration of Sea Areas took effect in 2002. The law requires sea area users to obtain use rights by applying for sea area use permits, and to pay user fees. The law also provides for the establishment of marine zones, which may be used for aquaculture or other activities. **Article 15** notes that plans for aquaculture industry and other industries involving the use of sea areas shall be made in conformity with the marine function zoning. The law also specifies a maximum of 15 year lease for aquaculture. The State Oceanic Administration (SOA), falling under the MoLR, is the statutory authority responsible for this law.

Marine Environment Protection Law (China, 1999)
The Marine Environment Protection Law, adopted in 1982 and revised in 1999, was enacted "to protect and improve the marine environment, conserve marine resources, prevent pollution damages, maintain ecological balance, safeguard human health and promote sustainable economic and social development". The law does not specifically refer to aquaculture, but it contains various provisions for control of water pollution and protection of habitats, such as mangroves and coral reefs, that would apply to aquaculture development.

Law on Prevention and Control of Water Pollution (China, 2008)
The law was adopted in 1984 for the purpose of preventing and controlling water pollution, and most recently amended in February 2008. Article 9 of the new amendments to the Water Pollution Prevention and Control Act require that a discharger meet: (1) standards for water pollutant discharge and (2) the total control target for major water pollutant discharge. Chapter IV (Section Four) addresses the prevention and control of agricultural and rural water pollution, including specific reference to aquaculture in Article 50 that refers to "scientific determination of breeding density and reasonable utilization of feed and drugs in aquaculture".

Scope of environmental assessment
The scope of the environmental assessment depends on the nature of the proposed project and special programme. According to the Law on Environmental Assessment, the report of the environmental impacts of a construction project shall include the following elements:

a. an introduction of the construction project;
b. description of environment surrounding the construction project;
c. an analysis, prediction and appraisal of the environmental impacts that may be caused by the construction project;
d. the measures for protecting the environment of the construction project as well as a technical and economical demonstration;
e. an analysis of the economic gains and losses of the environmental impacts that may be caused by the construction project;
f. suggestions for carrying out environmental monitoring over the construction project;
g. conclusion of appraisal of the environmental impacts.

EIA requirements of "relevant special programmes" as specified in the Law on Environmental Assessment shall include the following elements:

a. an analysis, prediction and appraisal of the environmental impacts that might occur if the programme is implemented;
b. the countermeasures for predicting or mitigating the unfavorable environmental impacts;
c. the conclusion of the appraisal.

At the construction project proposal stage, the SEPA or EPB decides the type of EIA required (screening), *i.e.* an EIA report, an EIA form, or an environmental registry form. Four project types require SEPA approval: specifically (1) projects involving state secrets or nuclear facilities, (2) cross-boundary projects involving two or more provinces, (3) projects that are likely to produce cross-boundary pollution, the impacts of which cannot be agreed to by the different provinces, and (4) projects valued at or over 20 million yuan (approximately USD 2.5 million). The provincial, county and municipal levels are involved with approval of other projects.

Environmental aspects are also included through the zoning and licensing systems for aquaculture as required by the laws highlighted above. In particular, the "Regulation guideline for prevention of pollution applied to marine environment pollution caused by marine engineering projects" and "Regulation guideline for prevention of pollution applied to coastal environment pollution caused by coastal engineering projects" request that development, establishment or reconstruction of mariculture of certain scale have to be aligned with the requirement for environmental protection. Use of zoning for sea-based aquaculture is widely promoted in China, although coverage of coastal areas is still incomplete.

Recent EIA legislation requires EIA for freshwater aquaculture in sensitive ecosystems, but guidelines are required to clarify the definitions of sensitivity.

Aquaculture licensing

The aquaculture license system has been adopted based on the Fisheries Law since 1986 with significant implications for environmental management. During the past 20 years, the central and local authorities' attitude to aquaculture has been promotional, and the administration and management of aquaculture enterprises and individual farmers was relatively weak and considered insufficient. Since 2001, central government has started to strengthen planning of coastal aquaculture in order to reduce disease problems and protect the environment. Capacity for implementation and high priority given to economic performance, at local levels, remain a concern for effective implementation of such policies.

In 2002, MoA made new rules for aquaculture licensing. The Bureau of Fisheries issued a "Trial Scheme to improve the aquaculture licensing system" to extend the policy to the freshwater aquaculture sector. According to the Fishery Law (revised in 2004), provincial and local fishery administrations will have more flexible authority to make a number of supplementary regional regulations which are tailored to local conditions and regional development plans based on the rational utilization of the sea, and locations suitable for aquaculture activities, and areas for aquaculture are allocated in order to avoid conflicts with other activities, such as fishing ports, tourism and sightseeing spots and important national industrial projects. The Bureau of Fisheries of MoA has overall responsibility for the management of the aquaculture license system, although significant capacity is required at the local level for effective implementation.

New farms versus operational farms

Environmental assessment is required for "changed" or "expanded" projects, and as such it appears that aquaculture farms in inland and marine waters would be subject to further environmental assessment. Actual requirements depend on the scale of the farm. In marine waters, this requirement is regulated under the Marine Environment Protection Law, but the implementation situation in freshwater environments is less clear.

Environmental monitoring

Monitoring is a compulsory part of the EIA process in China and it is traditionally carried out during the project construction and operation phases. As a result, monitoring during the project construction phase may influence the SEPA or EPBs' decision whether to allow the project operations to commence. EPBs and developers share the responsibility for monitoring. In the Environmental Impact Report, monitoring aims at integrating with the proposed environmental management strategy and would detail the extent of monitoring, the sites chosen, time and frequency of sampling, a strategy of data analysis and quality control measures during the construction and operation phases. In addition, the environmental management strategy should identify who is responsible for overall project environmental management and for monitoring individual environmental parameters. Project developers usually undertake routine monitoring of pollution sources and are normally required to focus on the four key issues: air and water pollution, waste and noise.

No specific guideline documents for environmental monitoring associated with the management of aquaculture projects or special programmes were available for review, and it is unclear whether there are any such guidelines available.

Sectoral environment monitoring

China also has an extensive network for environmental monitoring of aquaculture areas, under the Fishery Environment Monitoring Network (FEMN). The Fishery Environment Monitoring Center (FEMC) is based in Beijing (under the MoA), and the network has grown from seven in 1985 to over 100 operating units or sites at provincial and local levels covering 20.58 million ha (MoA and SEPA, 2006). The network covers both inland and near-shore coastal areas, and the system is continuing to expand and the monitoring techniques are improving. The results from the fishery environment monitoring network are published annually in the "Report on the State of the Fishery Eco-Environment in China" by MoA and SEPA (MoA and SEPA, 2006).

Outside of the MoA network, other environmental monitoring programmes have been established. For example, in 2002, SEPA also established offshore eco-environmental monitoring substations in seven major sea areas and gulfs, further expanding the marine area monitored.

Voluntary instruments

Numerous guidelines have been issued, at local level, provincial level, sectoral level and national levels, on various topics related to aquaculture siting, production and marketing, covering the whole supply chain (i.e. from hatchery to consumer), and intended to regulate several quality aspects including general operations, inputs (water, feed, drugs) and environmental protection, in addition to traceability.

At the end of 2002, the government launched the Wholesome Agriculture (including aquaculture) Production Action Plan. There is also increasing interest in certification for aquaculture products, and an increasing number of schemes, such as green certification and organic certification. The growing number of certification programmes and possible competition amongst certification schemes has the potential to result in confusion amongst producers, buyers and consumers (Liu, 2007; Corsin, Funge-Smith and Clausen, 2007), but the following are mentioned.

Safety agri-food certification is a scheme developed by the Centre for Agri-food Quality and Safety (CAQS) of the Ministry of Agriculture. The scheme was formally established in 2003 and it is implemented through three centres of which one is dedicated to fisheries products with 68 provincial level agencies and over 3 000 inspectors.

ChinaGAP is a scheme which was initiated in 2003 by the Certification and Accreditation Administration (CNCA), a government agency under the General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China (AQSIQ), which is directly under the State Council of the People's

Republic of China. GAP standards for a wide range of commodities were issued in 2005 and began implementation in 2006. Standards have been developed along similar lines to GLOBALGAP, with which a MoU was also signed to benchmark the ChinaGAP standards to the GLOBALGAP scheme. Different from GLOBALGAP, however, products produced in ChinaGAP certified farms are labelled as such. ChinaGAP standards for the aquaculture sector now include an overarching aquaculture base module in addition to another 15 commodity/system-specific modules relevant to several fish species (including tilapia and carp), shrimp, crabs and turtles, that includes various environmental parameters.

The Green Food standard scheme is also promoted by the Ministry of Agriculture through its Green Food Development Center, which is under the Green Food Administration Office. Green Food standards are not organic standards, although the two share some similarities. The Green Food standards address issues beyond food safety to include the environment, fertilizers, pesticides and other chemicals and set maximum dosages for each. Farms compliant to these standards can market products as "Green Foods" on the domestic market. At present there are almost 5 000 certified producers, of which 230 are producers of fisheries products.

The use of voluntary instruments to improve environmental management is also expected to increase in future, as emphasized in The National Eleventh Five-year Plan for Environmental Protection (2006–2010) (English version release date: 5 March 2008) that "China will vigorously popularize the knowledge about environmental science and implement the "environmental science popularization initiative in 10 000 villages of 1 000 towns". It will promote environmental label and certification, and advocate green consumption, green office and green procurement".

Practices

Environmental assessment

Environmental assessment and monitoring practices

The State Environmental Protection Administration now has a well-developed EIA procedure and technical guidelines are in place, but these are not specific for aquaculture.

Environmental monitoring procedures are however now well developed to support the fishery environmental monitoring network, to facilitate sample collection and analysis and facilitate comparisons in time and space. The monitoring network reports annually on the following parameters in freshwater and marine environments across China:

- nitrogen and phosphorus;
- COD;
- oil pollution, phenolic compounds;
- heavy metals (copper, cadmium, arsenic, lead);
- pollution incidents.

The Fishery Environment Monitoring Network covers widely fishery waters in China, including inland and coastal aquaculture areas. The focus is mainly on water quality, and adherence to water quality standards in fishery areas.

There has been increasing use of zoning in coastal areas of China, and some models have been developed for assessing carrying capacity. For example, Nunes *et al.* (2003) describe a multi-species model for shellfish polyculture in coastal embayments, and an application of the model to a test site (Sanggou Bay, Northern China) used for large-scale long-line cultivation of the Chinese scallop *Chlamys farreri*, the Pacific oyster *Crassostrea gigas* and the kelp *Laminaria japonica*. Development and improvement of models for predicting carrying capacity and integrated aquaculture systems is considered an important area for future research and development in China. Increasing research is also being conducted on environmental carrying capacity associated with intensive cage farming (e.g. Cai and Sun, 2006).

Environmental quality objectives

There are three categories of environment quality standards related to aquaculture in China that are used in the environmental assessment process and for monitoring. These cover (i) national standards (GB series), (ii) sectoral standards (SC series) and (iii) "hazard free aquaculture products standards" (NY series), and are briefly described as follows:

The **first set** covers national standards including:

- groundwater environment and quality standards;
- seawater quality standard;
- fishery water quality standard;
- marine sedimentation quality standards;
- environment requirements of production sites for hazard free aquaculture product.

Surface Water Quality Classification and Standards

National standards for surface water quality are detailed in regulation GB3838-1983, and have been successively revised in 1988 (GB3838-1988) and in 2002 (GB3838-2002). Surface waterbodies are ranked into five quality classes according to their utilization purposes and subsequent protection objectives, as defined in a regional zone classification issued by the municipal EPB:

- Class I is mainly applicable to spring water and to national nature reserves.
- Class II is mainly applicable to first class protected areas for main drinking water sources, for the protection areas of rare fish species, and for spawning grounds for fish and shrimp.
- Class III is mainly applicable to second class protected areas for main drinking water sources, and to protected areas for the common fish and for swimming areas.
- Class IV is mainly applicable to water for industrial use and entertainment which has no direct contact with the human body.
- Class V is mainly applicable to waterbodies for agricultural use and landscape requirement.

Chemical criteria are applicable to these five classes (Burgeap and Sogreah, 2007).

Quality Standard for Marine Water

According to Quality Standard for Marine Water (GB3097-1997) issued by SEPA, national marine waters are divided into four quality-grades associated with different environmental functions:

- Marine fishery waters, marine nature reserves and protected areas for rare and endangered marine species are identified as Class I environmental function areas that should meet Grade I national marine water quality standards.
- *Mariculture* area, sea bath, sea sports or entertainment areas where people have direct exposure to seawater as well as industrial water in direct relation to human food are Class II environmental function areas that should meet no lower than Grade II national marine water quality standards.
- Generally, industrial water areas and coastal scenic spots are Class III environmental function areas that should meet no lower than Grade III national marine water quality standards.

- Waters such as port area and marine development areas are Class IV environmental function areas that should meet no lower than Grade IV national marine water quality standards.

All marine aquaculture activities should be operated under the quality of seawater in compliance with the requirements of Grade II marine water quality standards. According to SEPA (SEPA, 2006a), there are a total of 651 coastal environmental function areas in coastal seas across China. Among them, 80 fall into Class I, 268 into Class II, 73 into Class III and 230 into Class IV.

Water Quality Standard for Fisheries
Water Quality Standard for Fisheries (GB11607-89), issued by SEPA regulates requirements and quality standards for fishery activities. No specific indicators have been developed for aquaculture, but there is ongoing work on establishment of standards for aquaculture. The Bureau of Fisheries (Bureau of Fisheries Management and Fishing Port Superintendence), falling under the MoA, is responsible for interpretation of the standards.

The second set of standards available is sectoral standards, which are issued by the Ministry of Agriculture:

- standard testing method for antibiotic residues;
- chemical residue in fishery products;
- malachite green, nitrofuran testing methods;
- mollusc toxin (PSP);
- shellfish poison;
- environment request for producing marine shellfish;
- specifications for ecological environment monitoring of fisheries;
- requirements for water discharge from mariculture;
- requirements for water discharge from freshwater pond aquaculture.

A third (final) set of standards has been developed – "hazard free aquaculture product standards" - that were issued by the Ministry to Agriculture and address the following:

- freshwater aquaculture water quality;
- mariculture water quality;
- aquatic product drug residue content limit;
- code for the use of veterinary drug products in aquaculture;
- aquafeed safety limit;
- limit of hazardous substances in fisheries products;
- criteria for assessing environment of production sites.

The "hazard free aquaculture product standards" are generally regarded as one part of the sectoral standards of MoA but with a different serial number.

Environmental monitoring
The Fishery Environment Monitoring Network, coordinated by the Bureau of Fisheries, is well developed in China. The 2006 annual report mentions that the fishery ecological environment in China remains good in general while some parts were seriously polluted by nitrogen, phosphate, oil and copper (MoA and SEPA, 2006). Environmental contamination as a food safety risk has become a new priority in the aquaculture sector (Ellis and Turner, 2007). In March 2007, the Ministry of Health released a draft of a new food safety coordination law to the public via the internet. In 2006, the Bureau of Fisheries of the Ministry of Agriculture announced a nationwide inspection targeting forbidden chemicals in the fish market.

Personnel and costs
The costs of conducting an EIA and monitoring associated with an EIA are normally paid for by the company making the application. The costs of the Fishery Environment Monitoring Network and the analysis of results are paid for by government budgets. Costs associated with compliance with environmental monitoring and application for certificates at the farm level are normally paid for by the farmers.

Difficulties and constraints in practice
The legal basis for EIA and environmental management is comprehensive, but the major concern relates to implementation, particularly at the local level. A common theme in several reports on EIA and environmental management in China is the need for strengthening of environmental management capacity among local government and the farming community. The major difficulties include:

- impacts of other sectors on aquaculture environments and proper assessment and management of these impacts;
- a concern raised during the recent FAO workshop on aquaculture certification (FAO, 2008) highlighted the difficulties that small farmers face in funding and conducting environmental monitoring required for compliance with increasing certification requirements.

The quality of environmental assessment has been a concern of SEPA who has taken measures to improve the conduct of EAs. New EIA Qualification Rules from SEPA impose stricter supervision of EIA agencies and also encourage various reforms, including foreign participation in reorganization of the EIA agencies in order to make the EIA service market more competitive. The EIA Qualification Rules strengthen the continuing supervision powers of SEPA after the qualification certificates are issued to EIA agencies. SEPA conducts selective inspections on such EIA agencies from time to time, publishes the inspection results and imposes administrative penalties (as discussed below) on those found in violation of relevant rules and regulations.

Effectiveness

Technical appropriateness
The methods used for environmental assessment and monitoring are being improved. However, for aquaculture, the need to improve the standards for monitoring of environmental conditions in farming areas is recognized.

Use of data to improve performance of aquaculture
Environmental monitoring data generated through the Fishery Environment Monitoring Network is being used to identify and respond to pollution problems, and also for reporting on the state of aquatic environments (e.g. MoA and SEPA, 2006). An annual report on the fishery environment is published which is used by government to review both the environmental status of fishery waters and environmental trends. Provincial governments are also increasing attention to water quality and some also release an annual report on fishery environmental quality. These reports include both aquaculture and fishery environments.

Impact of EIA and monitoring on environmental protection
Fishery authorities generally consider that the pollution from other sectors is a serious environmental concern. The use of environmental assessment within planning studies and licensing procedures is considered to have contributed to environmental protection.

Feedback and review
Environmental monitoring data is increasingly used to take management measures. The extent of use of environmental monitoring data in the aquaculture industry is uncertain

as no detailed consultation was conducted with private farmers during the preparation of this review. The public consultation process for environmental assessment in China was strengthened by the release of the Environmental Assessment Law and has been strengthened since then (Moorman and Ge, 2006) China's Measures for the Disclosure of Environmental Information also became effective on 1 May 2008, and are expected to further improve public participation and review of environmental information, with benefits to both the aquatic environments used by aquaculture, and the sustainable development of the sector.

Perceptions of stakeholders

No information was available on this topic.

Improvements

The following recommendations for improvements have been synthesized from the various reports reviewed (including synthesis from SEPA (2006b) and OECD (OECD, 2006a; 2006b)), The National Eleventh Five-year Plan for Environmental Protection (2006–2010) (English version release date: 5 March 2008) and consultations with experts in China, and are assumed to be generally valid:

- strengthening environmental policy implementation at the local level, where economic priorities to date have over-ridden environmental concerns;
- improving awareness of need to consult and involve stakeholders in environmental management, planning and decision-making;
- strengthening monitoring, inspection and enforcement capabilities at local levels, and use of environmental data to improve management.

And, specifically relevant also for aquaculture:

- strengthening efforts to protect and improve water quality in coastal waters and adjacent regional seas from land-based pollution sources, and upgrade environmental management regulations and government oversight in the aquaculture industry;
- protection of the marine environment is emphasized in the Eleventh Five Year plan which specifically mentions the need for improved pollution control for mariculture;
- development of standards and guidance for ecological aquaculture. China has a long history of ecological aquaculture, but recognizes the need for research and development to provide a scientific basis for most suitable models;
- improvement in environmental assessment and carrying capacity procedures for coastal aquaculture;
- improvement in guidelines for planning and zoning of aquaculture areas;
- the need for clarity on environmental standards for aquaculture effluent and water quality for aquaculture areas. Several standards are issued at state level, and now provinces are developing various implementation standards;
- investigation, monitoring and control of marine pollution stepped up by improving the pollution monitoring network;
- development of regulations on EIA process for different scales of aquaculture;

A short complementary review of the environmental impact assessment procedures for China, Hong Kong SAR, is also provided in Box 1.

BOX 1

EIA in aquaculture in China, Hong Kong SAR

In China, Hong Kong Special Administrative Region (SAR), an EIA Ordinance was enacted in 1997 to provide for assessing the impact on the environment of certain projects and proposals, for protecting the environment and for incidental matters. The EIA Ordinance is administered by the Hong Kong Environmental Protection Department, which maintains a web site (China, Hong Kong SAR, 2008) that provides details of the procedures and a comprehensive list of supporting guidelines. Aquaculture is included in the list of projects requiring an EIA, which applies only to marine cage fish farming. The Ordinance states that among the designated projects requiring an environmental permit is "A fish culture zone – (a) more than 5 ha in size; or (b) a boundary of which is less than 500 m from the nearest boundary of an existing or planned – (i) marine park or marine reserve; or (ii) bathing beach." Freshwater aquaculture is not included within the scope of projects requiring an EIA. An example on expected scope and content of the EIA report is provided in Annex A. A detailed assessment of all aquaculture zones was conducted in China, Hong Kong SAR in 1990, providing perhaps the only examples of a sector-wide environmental assessment in the region (Wu *et al.*, 1999). The outcome led to changes in the management of aquaculture zones, largely for marine fish cage culture.

Source: Contribution by Michael Phillips and Koji Yamamoto (NACA)

INDIA[7]

Requirements

Environmental assessment

In India, environmental impact assessment of certain development activities is a requirement under the law. As per the Environmental Impact Assessment Notification, 2006 issued under Environment (Protection) Act, 1986, developmental projects, those listed in the Schedule of the said notification, attract clearance under the same notification. However, in the Environmental Impact Assessment Notification, 2006 aquaculture projects are not listed, hence, they do not attract the provisions of the said notification. All developments in the Coastal Regulation Zone area attract the provisions of Coastal Regulation Zone Notification, 1991 that has been issued under the Environment (Protection) Act, 1986. Earlier the auaculture units falling in the Coastal Regulation Zone area attracted the Coastal Regulation Zone Notification, 1991 and clearance under the said notification was required for such projects. However, the Coastal Aquaculture Authority Act, 2005 overwrites the Coastal Regulation Zone Notification, 1991. Hence, clearance under Coastal Regulation Zone Notification, 1991 for aquaculture units is not mandatory. However, other facilities such as processing units, ice plants, feed plants, etc. required for aquaculture units would attract the provisions of Coastal Regulation Zone Notification, 1991.

As noted by the Aquaculture Authority (Aquaculture Authority – India, 2001), "although we have fairly elaborate policies and legislation governing issues related to industries", there is no specific environmental legislation designed specifically for aquaculture or shrimp farming".

Aquaculture is not specifically named within existing EIA legislation and it is separately regulated under the Coastal Aquaculture Authority (CAA), under the Department of Animal Husbandry, Dairying and Fisheries of the Ministry of Agriculture. The Coastal Aquaculture Authority Act, 2005 (24 of 2005) enacted

[7] Contribution by Michael Phillips, Narayan Kutty and Koji Yamamoto.

by the Central Government on 23 June 2005 provides for the establishment of the Coastal Aquaculture Authority for regulating aquaculture in coastal areas and matters connected therewith or incidental thereto. The Act mandates the Central Government to take measures for regulation of activities connected with coastal aquaculture.

"Coastal aquaculture" is defined as "culturing, under controlled conditions in ponds, pens, enclosures or otherwise, in coastal areas, of shrimp, prawn, fish or any other aquatic life in saline or brackish water; but does not include fresh water aquaculture". There is also no reference to offshore or open sea aquaculture. The Coastal Aquaculture Authority is responsible for the following functions:

i) to make regulations for the construction and operation of aquaculture farms within the coastal areas;
ii) to inspect coastal aquaculture farms with a view to ascertaining their environmental impact caused by coastal aquaculture;
iii) to register coastal aquaculture farms;
iv) to order removal or demolition of any coastal aquaculture farms which is causing pollution after hearing the occupier of the farm;
v) to enter on any coastal aquaculture land, pond, pen or enclosure and
   a. make any inspection, survey, measurement, valuation or inquiry;
   b. remove or demolish any structure therein;
   c. do such other acts or things as may be prescribed.
vi) to perform such other functions as may be prescribed.

The emphasis of the CAA has been on shrimp farms, with a strong attention to environmental impacts and management. It also issues guidelines for planning and overall management of the coastal aquaculture sector.

Administration and responsibilities

The following Table 16 provides an overview of some of the other agencies and institutions involved directly and indirectly in environmental management of aquaculture in India.

The States have significant responsibility for management of coastal aquaculture in India. The Table 17 shows some of the state government department responsibilities in coastal aquaculture development.

TABLE 16
Agencies and institutions involved in environmental management of aquaculture

Institution (s)	Responsibilities
Coastal Aquaculture Authority (CAA)	The CAA regulates aquaculture in coastal areas. Further details can be found at http://aquaculture.tn.nic.in
Ministry of Agriculture (MOA)	MOA is the Central Government Ministry with responsibility for aquaculture and fisheries (through the Department of Animal Husbandry, Dairying and Fisheries)
The Indian Council of Agricultural Research (ICAR)	ICAR operates under the Ministry of Agriculture as an autonomous national organization which conducts and promotes research and training in the field of agriculture and allied sciences, including several specialised research institutes involved with aquaculture.
The Marine Products Export Development Authority (MPEDA)	MPEDA was constituted in 1972 under the Marine Products Export Development Authority Act 1972 (No.13 of 1972). MPEDA is concerned with export promotion and supports fisheries and aquaculture in various ways related to increasing seafood exports, specifying standards, processing, marketing, extension and training.
Ministry of Environment and Forests (MOEF)	MOEF is a cabinet Ministry in the Government of India, and is responsible for the planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programmes in the country.
State Agricultural Universities (SAU)	Several of the State Agricultural Universities have full fledged fisheries faculties including Departments of Fishery Environment. These are also technically within the ICAR though they function under the States. Some State level EIA studies are conducted by SAUs.
Private associations	Private sector associations involved with aquaculture, including the farmers' associations, All India Shrimp Hatchery Association, and others that are also active in extension, information exchange and promotion of better management among members.

TABLE 17
State agencies and institutions involved in environmental management

Institution (s)	Responsibilities
State Fisheries Department	Formulation of action plans for marine, freshwater and brackish water fisheries and aquaculture, promotion and extension of support services for modernization and intensification of production methods, controlling input delivery and quality control and market infrastructure development. State Department is also involved in review of CAA license applications. District fisheries authorities, where present, are under the management of the State Government. District Department also involved in review of CAA license applications
Industries Department	Formulation of policies for coastal industrial development such as coastal special economic zones (SEZs). Government of Andhra Pradesh has issued orders for formulating SEZ Policy to provide a comprehensive framework for establishment, operation and sustainability of aquaculture enterprises within the coastal SEZs in the State. Fish and shrimp processing, hatcheries and aquaculture farms are treated as polluting industries and need a No-objection certificate from state pollution control board/development commissioner for establishment within SEZ.
State Pollution Control Board	The Board constituted in 1976 functions through its zonal offices in coastal regions. The Board is responsible for the enforcement of the provisions of the Water (Prevention and control of Pollution) Act, 1974, Water Cess Act 1977, The Air (Prevention and control of Pollution) Act 1981, The Environment (Protection) Act, 1986 and Hazardous Chemicals and Wastes Handling Rules of 1989.
Environment, Forests, Science and Technology Department	Promotion of environmental conservation and management and coordination of various state and central agencies. Preparation of coastal zone management plan and implementation of Coastal Regulation Zone notification is one of the responsibilities of the Shore Area Development Authority functioning under this Department.
Irrigation Department	Basin-wide planning of state water resources, management of farmers irrigation associations, watershed development
State Ground Water Directorate	Estimation and monitoring of groundwater resources and suggest measures for maintaining water balance.
Panchyat Raj and Rural Development Department	Planning, construction, maintenance of rural water supply, minor irrigation of command areas of less than 40 ha. Implementation of development and welfare programmes for coastal communities. Implementation of Water, Land and Trees Act 2002.

TABLE 18
Further agencies and institutions involved in environmental management

Institution (s)	Responsibilities
Acharya N G Ranga Agricultural University (ANGRAU)	Education, research, extension and training in fisheries and aquaculture through Fisheries College and research institutes.
Andhra Pradesh Environmental Training and Research Institute (EPTRI)	Training, research and consultancy in various environmental aspects including water quality monitoring, GIS mapping etc.
Jawaharlal Nehru Technological University (JNTU)	Education, training and research in water resource engineering including aquaculture farm engineering
National Environmental Engineering Research Institute (NEERI)	Has regional stations undertaking research and consultancy on environmental impact analysis and water resource engineering.
Central Marine Fisheries Research Institute (CMFRI)	Under the Indian Council of Agricultural Research (ICAR), this institute undertakes research and development in fisheries resources management, mariculture and technology transfer.
Central Institute of Brackishwater Aquaculture (CIBA)	Located at Chennai and also under ICAR, this institute undertakes research and development in managing and promoting brackishwater aquaculture and technology transfer.
Central Institute of Freshwater Aquaculture (CIFA)	Located at Chennai under ICAR, this institute undertakes research and development in managing and promoting freshwater aquaculture and technology transfer.
Central Institute of Fishery Technology (CIFT)	Located at Vishakapatnam and also under ICAR, this institute undertakes research and development in fishery technology including value addition.
Indian National Centre for Ocean Information Services (INCOIS)	Under the Department of Ocean Development, Government of India, Hyderabad this centre provides information on potential fishing zones and has excellent facilities for fishery forecasting by using GIS and RS.
National Remote Sensing Agency (NRSA)	This agency, under the Department of Space, Government of India, undertakes consultancy and research on using RS and application of GIS for coastal aquaculture planning.
Andhra Pradesh State Remote Sensing Application Centre (APSRAC)	This centre undertakes research and training in GIS and EIA studies on aquaculture.
The State Institute of Fisheries Technology, Kakinada (SIFT)	Under the Andhra Pradesh State Fisheries Department, this institute provides training and extension services in the area of scientific pond management, seed and feed testing and technical services.
Marine Products Export Development Authority (MPEDA)	Operates as part of the Ministry of Commerce, Government of India. Provides technical support for the development of shrimp farming through subsidy for farm development, processing and hatcheries. Training, research and trade promotion are other important activities of the MPEDA.

There are a number of research, development and training institutes supporting aquaculture development in India as summarized in the Table 18.

Other statutory authorities and R&D organizations for coastal area management, including environmental management responsibilities, under central and state government are also noted below.

TABLE 19
Statutory and R&D organizations for coastal area management

National Coastal Zone Management Authority (NCZMA)	Established under the provisions of the Environment Act 1986, coordinates actions of the State Coastal Zone Management Authorities and the union Territory Coastal Zone Management Authorities, assesses development proposals, reviews violation of provisions and actions against violation and prepares integrated coastal zone management plans.
State Coastal Zone Management Authority (SCZMA)	Responsible for the preparation of the integrated coastal zone management plan as per the CRZ (Coastal Regulation Zone) and to look into the violations of CRZ, identification of ecologically sensitive areas and preparation of area specific management plans.
Integrated Coastal and Marine Area Management Project Directorate (ICMAM)	Established under the Department of Ocean Development in 1998 at Chennai this directorate has the mandate of capacity building, consultancy and research in ICAM
National Institute of Ocean Technology (NIOT)	An autonomous organization of the Department of Ocean Development (Government of India) which undertakes research and training in the sustainable utilization of coastal and ocean resources.

Policies

A summary of policies and acts related to shrimp aquaculture is shown in Table 20.

TABLE 20
Policies and acts related to shrimp farming in India

Policy	Legal framework
42nd Constitutional Amendments Article 48 A	The 1977 Constitution (Amendment) Act Article 48 specifically places an obligation on the nation to protect the environment. Protection of the environment is one of the fundamental duties of the citizen.
Aquaculture Authority of India	Constituted by the Government of India in 1997 under the Environment Act 1986 within the administrative control of the Ministry of Agriculture in response to the Supreme Court directive for the regulation of shrimp farms in coastal zone. Became Coastal Aquaculture Authority (see above).
National Coastal Zone Management Authority (NCZMA)	This Authority was constituted under the provisions of the Environment Act in 2001 for coordinating the state CZMAs and examination of proposals for the modification of coastal zone management plans and approvals. But this is only an advisory committee which meets whenever necessary and reconstituted once in every two years.
National Biodiversity Authority	Constituted by the MOEF under the Biodiversity Act 2002 and rules 2004 to promote conservation, sustainable use and equitable benefit sharing by constituting state Biodiversity Boards and Biodiversity Management Committees at the Panchayat level to prepare biodiversity registers.
Central Ground water Authority (CGWA)	The CGWA has been constituted in 1997 under Environment Act to regulate indiscriminate drilling and withdrawing of ground water and to issue necessary regulatory directive to protect ground water.
Policy statement for the abatement of pollution, MOEF, 1992	The Environmental Impact Assessment Notification for certain type of activities including large-scale shrimp aquaculture. The public hearing and environmental management plan are also part of the procedure for obtaining no-objection certificates as per 1997 and 2001 amendments to the Environment Act 1986. National Biodiversity, Strategy and Action Plan (NBSAP) and the National Environment Policy 2004 documents on shrimp farming.
A P Farmers Management of Irrigation Systems Act 1997	Under this Act a structure of farmers' organizations consisting of water users associations, has been created and given the responsibility of water management under command areas. As per the latest revisions it is also possible to form such an institutional structure for the users of creek/river water for shrimp farming.
A P Pan chayat Act 1953	This Act provides for the duties of a Panchayat to minor irrigation works having a command area of less than 40 ha and also maintenance of drinking water system.
A P Forest Act 1967	Under this Act the government may declare any wasteland as protected forest. Provision also exists for the formation of joint forest management committees. Thus it could play an important role in the rehabilitation of the unutilized shrimp developed area.
A P Water, Land and Trees Act 2002	This Act is designed to promote water conservation and tree cover and to regulate the exploitation and use of ground and surface waters. The A P Water, Land and Trees Authority will supervise the implementation of the Act as per the rules framed under the Act.
Factories Act 1948	Compulsory disclosure of information by the occupier and community has a right to be provided information (applicable with respect to shrimp processing industries).

Scope of environmental assessment

The process of application for a Coastal Aquaculture Authority licence involves submission by a shrimp farmer/developer to a district level committee, following which the application is forwarded to the Directorate of Fisheries of the State/Union Territory as the Nodal Agency, and then with recommendation to the CAA for permission. The approval process was established principally to address environmental issues with the establishment of farms in the coastal area, considering both the siting of farms in relation to environmentally sensitive ecosystems and operational practices.

The scope of the Coastal Aquaculture Authority licence application includes environmental issues. The "Application for Authorization/approval of Shrimp Culture Farm/Shrimp Culture Pond: other than traditional and improved traditional which are already operating/proposed to be set up/constructed outside the coastal regulation zone as defined by the Coastal Regulation Zone notification (outside 500 m above HTL in the coastal area) and outside 1 000 m of Chilka and Pulicat lakes including bird sanctuaries namely Yadurapattu and Nelapattu (under Directions 6,7 and 9 of the orders of the Hon'ble Supreme Court of India in Judgement dated 11.12.1996 on Writ Petition (Civil) No.561 of 1994)" includes a number of environmental issues including:

- siting, with information to be provided with reference to the coastal zone regulation;
- farm design and layout;
- reference to an EIA or Environmental Management Plan (EMP) if carried out;
- effects of salinity, use of feeds and siltation;
- presence of effluent treatment plant.

The application is screened by a committee at state and district local levels and also includes site visits by the committee members, individually or collectively. Whilst EIA is encouraged in the process, the application does not require an EIA to be successful unless farms are beyond a certain size based on farm area.

According to CAA/MOA guidelines, shrimp farms with a net area of 40 ha or more should conduct an EIA and incorporate an environmental monitoring and management plan (EMMP). All farms of 10 ha and more, but less than 40 ha are also required to furnish detailed information on the aforesaid aspects in the application. For farms greater than 10 ha, an Environmental Impact Statement is required to be submitted with the CAA application. Most Indian shrimp farmers are small-scale farmers and therefore are not required to carry out a full EIA or EMP. This is a concern where clusters of small farmers around small creeks may lead to self-pollution, although this concern may be addressed through improved local management measures. Strategic environmental assessment or similar processes on aquaculture plans are not conducted. There is some interest in integrated coastal zone management at state level, but to date limited or no plans involving aquaculture have been prepared.

The EIA and management/monitoring plan, prepared as part of the application for CAA licence should be submitted for review by the District Committees/Nodal Agencies. The Committees involve various government departments, including the State Pollution Control Board, and are reviewed by a range of relevant departments. In Goa, for example, according to the Coastal Aquaculture Authority (2006), the committees are established as follows:

- District level committees (DLC) for regulating coastal aquaculture are headed by the Collector (Head of Civil Administration) of the District, and Assistant Director of Fisheries of the respective district as Member Secretary. The other members include the following from the State Administration:
  - Deputy Director, Agriculture;
  - Director, Science, Technology and Environment;
  - Senior Town Planner, Town and Country Planning;

  - Executive Engineer, Irrigation Department;
  - Senior Extension Officer, Brackishwater Fisheries Development Agency (BFDA);

  Representative of Goa, State Pollution Control Board.
- The State-Level Committee (SLC) is headed by the Secretary (Fisheries) with Director of Fisheries as the Member Secretary. The other members of the committee are:
  - Collectors from the two District Aquaculture Committees;
  - Director, Agriculture;
  - Director, Science, Technology and Environment;
  - Chief Town Planner, Town and Country Planning;
  - Executive Engineer, Irrigation Department;
  - Representative of MPEDA, Karwar,;
  - Chief Executive Officer, Brackishwater Fisheries Development Agency (BFDA);
  - Chief Engineer, Irrigation Department;
  - Member Secretary, Goa, State Pollution Control Board.

New farms versus operational farms

The Aquaculture Authority application and registration process covers existing and new farms. The Aquaculture Authority licence is for the period of five years. During renewal it may have to include any modifications during that five year period.

Environmental monitoring

Environmental monitoring is required under the CAA licenses as noted above, to include the items specified in the EMMP.

The guidelines of the Ministry of Agriculture define standards for wastewater as defined in Table 21.

TABLE 21

Guidelines/standards for wastewater from coastal aquaculture farms in India

Parameters	Final discharge point	
	Coastal marine waters	Creeks/estuaries
pH	6.0–8.5	6.0–8.5
Suspended solids (mg/l)	100	100
Dissolved oxygen (mg/l)	Not less than 3.0	Not less than 3.0
Free ammonia (as NH^3-N) mg/l	1.0	0.5
Biochemical oxygen demand – BOD (mg/l)	50	20
Chemical oxygen demand – COD (mg/l)	100	75
Dissolved phosphate (as P) (mg/l)	<0.4	<0.2
Total nitrogen (as N) (mg/l)	2.0	2.0

It may be noted that the effluents/solid waste generated from the aquaculture units should meet the standards prescribed by the concerned State Pollution Control Boards or UT Pollution Control Committees. All units of the aquaculture farm should obtain necessary clearances/No Objection Certificate under the Water (Prevention and Control of Pollution) Act, 1974 and the Air (Prevention and Control of Pollution) Act, 1981.

Guidelines and voluntary instruments

There are a number of guidelines and voluntary based approaches to environmental management in India, issued in the form of codes of practice and best practice guidelines by a number of government agencies. These are mostly focused on coastal aquaculture.

TABLE 22
Guidelines and voluntary instruments for aquaculture in India

Guideline/voluntary instrument	Origin	Scope
Ministry of Agriculture issued Guidelines for Sustainable Development and Management of Brackish Water Aquaculture (1995).	MOA, Department of Animal Husbandry, Dairying and Fisheries	The overall purpose of the Guidelines is to assist in formulating appropriate shrimp farming management practices and adopting measures for mitigating the environmental impact for management of shrimp pond wastes and utilisation of land/water resources in a judicious manner. They recommend States to identify lands that are fit for aquaculture and to discourage the conversion of agriculture land for aquaculture. The Guidelines also recognize the importance of wastewater treatment and prescribe standards for the treatment of wastewater discharged from aquaculture systems, hatcheries, feed mills and processing plants.
Guidelines on adopting improved technology for increasing production and productivity in traditional and improved tradition systems of shrimp farming	Coastal Aquaculture Authority (CAA, 2006)	Management of shrimp farming and effluent treatment. Water quality management and monitoring are described in paragraph 3.6 and 3.7 with providing optimal water quality parameters
Effluent treatment systems in shrimp farms	Aquaculture Authority	
Guidelines for Sustainable Aquaculture	MPEDA (2008)	Recommend appropriate management practices and measures for mitigating the environmental impact and utilisation of the land/water resources
Extension pamphlets/ Brochures	Central Institute of Brackishwater Aquaculture (CIBA), ICAR, Ministry of Agriculture and MPEDA	Provide farming practice for each step of the production

The guidelines issued by the Coastal Aquaculture Authority Act mandates the central government to take all such measures as it deems necessary or expedient for regulation of coastal aquaculture by prescribing guidelines, to ensure that coastal aquaculture does not cause any detriment to the coastal environment and the concept of responsible coastal aquaculture contained in the guidelines shall be followed in regulating coastal aquaculture activities to protect the livelihood of various sections of people living in the coastal areas. The CAA has issued a number of guidelines as noted in Table 22. Other guidelines on various aspects have been issued by the Ministry of Agriculture, Indian Council for Agriculture Research and the Marine Products Export Development Authority also as noted in Table 22.

These voluntary instruments consider mostly coastal aquaculture, mainly shrimp farming, and not inland aquaculture. MPEDA is presently drafting better management practice guidelines for *Macrobrachium rosenbergii.* The Government of Andhra Pradesh has brought in similar regulation for fresh water aquaculture including fresh water prawn farming. Committees of similar nature have been formed to license farms. MPEDA has been included as a member in the district level committees.

Practices

Environmental assessment

The practices used for environmental assessment of aquaculture in India are guided by the scope of EIA requirements as specified in the Coastal Aquaculture Authority application, as well as the items directly referred to in the application, which give special reference to the following environmental issues:

- farm location, and whether a whole or part of the farm land falls within mangroves, wetlands and other land types;
- nearby land uses, including environmentally sensitive habitats;
- water source;
- potential impacts on water logging of adjacent areas or pollution of drinking water sources;
- existence of wastewater treatment facilities;

- use of supplementary feeds, drugs and medicines;
- activities that may cause siltation, turbidity, with detrimental implications for local fauna and flora.

The coverage of the assessment within the licensing procedure is therefore quite wide.

Environmental monitoring

The scope of the environmental management and monitoring plan as required for larger scale farms, and as specified by the Coastal Aquaculture Authority, should cover the following items:

- impact on the water sources in the vicinity;
- impact on ground water quality;
- impact on drinking water sources;
- impact on agricultural activity;
- impact on soil and soil salinisation;
- wastewater treatment;
- green belt development (as per specifications of the State Pollution Control Board).

No detailed guidelines are however available on the monitoring requirements.

Personnel and costs

The practices and quality of EIAs has been discussed by the Ministry of Environment and Forestry in the Criteria for Registration of EIA Consultant Organizations (NRBPT, 2006). The quality problems associated with EIA as outlined in the introduction to the criteria include:

- improper/inadequate scoping for the EIA;
- consultants having inadequate understanding of EIA;
- poor quality of inputs to EIA;
- problems of "cut and pasting" in EIA reports;
- lack of checks on competence of EIA consultants;
- no liability of EIA consultants;
- very few in house reports.

In response to these problems, the MOEF has provided more guidance on report structure, checklist and scoping, and the National Registration Board for Personnel and Training (NRBPT), a constituent of the Quality Council of India, has launched a scheme for registration of EIA consultant organizations. This scheme provides detailed requirements for registration of organizations, and is intended to support improvement in the skills of organizations and persons conducting EIAs and to facilitate access to competent organizations.

Difficulties and constraints in practice

The main difficulties in implementation are:

- large number of farms involved;
- large numbers of small-scale farmers;
- lack of follow up monitoring;
- sometimes uncertain land ownership and complex leasing (renting) arrangements related to some existing small-scale farms;
- several of the aquaculture activities are undertaken in a disorganized manner. Some of them are temporary/illegal (being undertaken within mangrove area, wetlands, etc.).

Recent initiatives by the newly established National Centre for Sustainable Aquaculture (NaCSA) have however been highly successful in encouraging licensing of farms in aquaculture societies, with around 100 societies registered by early 2008.

Effectiveness

Technical appropriateness

There is good subject-wide coverage of the major environmental issues in coastal aquaculture. However it is recognized that the implementation of EIA can be improved.

Use of data for improved performance of aquaculture

The data obtained to date have not been directly used for improving environmental performance of aquaculture. Indirectly, the sectoral assessment conducted for the Aquaculture Authority of India has contributed to improved management of the sector.

Impact of EIA and monitoring on environmental protection

The implementation of the registration system has had a positive effect on environmental protection. However, a continued and wider coverage of the small-scale sector, which is the dominant type of aquaculture farming, would improve environmental protection

Feedback and review

There is some feedback and review of EIA data, for example in the case of the Environmental Impact Assessment Report submitted to the Supreme Court of India. Here, a total of 1 130 responses were obtained from the public prior to completion of the report.

Perceptions of stakeholders

The perception among many aquaculture stakeholders is that EIA is an administrative requirement, rather than management tool.

Improvements

Recommended improvements received from various contributors to this review include:

- further development of a framework for EIA and monitoring procedures for aquaculture. Some concerns also have been expressed that the scope of the EIA should be reviewed to cover the following in addition to those listed in the Coastal Aquaculture Authority Act:
  - effluent impacts;
  - social impacts;
  - air and noise pollution.
- development of EIA and monitoring procedures for mariculture, particularly given the growing interest in sea-farming in India (e.g. grouper, cobia farming);
- streamlining of procedures to improve the time taken for approval of CAA applications;
- development of systems for involving large numbers of small-scale farmers in the registration system, building further on the NaCSA model that has been highly successful in registration of small-scale farmers through societies;
- development of integrated plans for coastal areas that clearly identify suitable locations for aquaculture, and environmental assessments and management plans developed in the specified aquaculture zones;
- development of environmental management systems for inland aquaculture, with most focus to date having been on coastal shrimp farming.

INDONESIA[8]

Requirements

Environmental impact assessment

The Environmental Management Act No.23 (1997) provides the basis for application of EIA, which is required to engage in any business or activity likely to have a major and significant impact on the environment. In this regard, aquaculture is specified in the category of "fisheries" and subject to the EIA procedure (AMDAL), as established by Decree of the State Minister of the Environmental Affairs No.3/2000 and the Ministry of Environmental Decree No. 308, 2005, which specifies the types of activities for which an Environment Impact Analysis is compulsory. The two relevant Indonesian terms related to EIA are as follows:

- AMDAL *Analisis Mengenai Dampak Lingkungan Hidup* (Management of Environmental Impact Analysis); and
- ANDAL *Analisa Dampak Lingkungan Hidup* (Environmental Impact Assessment)

Government Regulation No.27/1999 re Analysis of Environmental Impacts (1999) provides that, when required, the EIA is part of the licensing procedure for the conduct of the concerned activity. It has been applied widely to large-scale coastal shrimp farm projects[9].

The 2004_Fisheries Law also requires a specific licence called SIUP (Surat Izin Usaha Perikanan) to engage in the fishery business, including aquaculture. However, small-scale fishermen and aquaculture farmers are exempt from such a requirement. Procedures for the granting of fisheries and aquaculture licences are regulated by Government Regulation No.54 of 2002 on Fisheries Business. The SIUP for the conduct of aquaculture in fresh, brackish or marine waters by an Indonesian company must be issued by the Provincial Governor or by the Regent or Head of the District/ Municipality, depending on the location of the farm. An EIA is among the documents required by companies when applying for the SIUP (other items include business plan, NPWP (tax identification number), company charter and aquaculture site location).

The Ministry of Marine Affairs and Fisheries have also issued various legal documents concerning the planning and operation of aquaculture farms, several relating to the environmental aspects of aquaculture development. The most important legal instrument is the Indonesian Fisheries Act No 31, 2004 which provides the basis for a number of environmental management measures within the aquaculture sector.

Administration and responsibilities

The administration of the environment and natural resources in Indonesia is being strongly influenced in recent years by the decentralization policy, with increasing decentralization of management responsibilities to the provincial, district and municipality governments. This process has significant implications for the practical management of environment and aquaculture, because of generally weak capacity existing at local levels of the administrative system.

The legal framework for environmental management in Indonesia has developed over the past two decades and according to a recent review by the Asian Development Bank (ADB, 2005) is well developed and tends to meet international standards. However, the increasingly decentralized policy setting in Indonesia has significant implications for *implementation*, and requires that some of the existing laws, regulations and technical guidelines are revised or renewed (ADB, 2005). The ADB review also notes the need for stronger enforcement of environmental laws and regulations, particularly in the field of environmental impact assessment.

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[8] Contribution by Michael Phillips and Koji Yamamoto.

[9] Although it has been widely applied, obtaining copies of EIA documents proved very difficult.

TABLE 23
Institutional responsibilities related to aquatic environmental management

Institution (s)	Responsibilities
Central level	
Ministry of Environment (MOE)	The responsibility of the MOE is to formulate policies and coordinate the environmental management programmes.
Ministry of Marine Affairs and Fisheries (MMAF)	MMAF was established in 1999 with the mandate to formulate policies and coordinate and manage marine and coastal exploration activities.
Ministry of Forestry (MOF)	MOF is responsible for regulating and managing commercial forest concessions, agro-industry activities and terrestrial and marine protected areas.
Badan Pengendalian Dampak Lingkungan (BAPEDAL) (Environmental Impact Management Agency).	This agency merged with MOE in 2002, with the principal task of management of environmental impacts, including (i) prevention and control of pollution and environmental damage, and (ii) improvement of the environmental quality in accordance with the existing legislation.
Provincial level	
Provincial Fishery Service (DKP-Dinas Keluatan dan Perikanan)	Responsible for fishery and aquaculture management at provincial level
Badan Pengendalian Dampak Lingkungan Daerah BAPEDALDA	Regional offices of BAPEDAL
District/municipality level	
District/municipality Fishery Service (DKP)	Responsible for fishery and aquaculture management at district/ municipality (kabupaten/kota) level

The institutional responsibilities for EIA and related aquatic environmental management matters are outlined in Table 23.

The key environmental laws as related to EIA in Indonesia are as follows:

Environmental Management Law No. 23/1997

The Environmental Management Act (EMA) superseded EMA No. 4/1982 and provides the basic (or umbrella) environmental law in Indonesia. It covers the principles, objectives and targets of environment management in Indonesia, rights and duties and the community roles, authorities to manage the environment, and the function of sustaining the environment. Of particular interest: Article 8 of the Law covers the environmental policy and management aspects in relation to the natural resources including the genetic resources; and Article 37 provides the community the rights to file for class action and provides the legal basis for the environment organizations to file suits against government on behalf of the public interest against unsustainable environmental practices.

Environmental Impact Assessment

The process of EIA, known in abbreviated Bahasa Indonesia as AMDAL, is a key responsibility of MOE and is an important instrument in determining the impact of projects on the environment. The Environmental Impact Management Agency's (BAPEDAL) tasks include the implementation of the national environmental policy, the preparation of guidelines on environmental impact management, the coordination of EIA processes, the monitoring and management of waste discharge, the promotion of environmental awareness and the settlement of environmental disputes.

With the government policy of decentralisation, local institutions have increasing responsibilities for management of aquaculture that includes environmental impact assessment and management. The Law 22/1999 and GR 25/2000 devolve around 80 percent of AMDAL's responsibilities to the districts. In light of serious technical capacity limitations in the districts, MOE was, in 2005, working on revising GR 25/2000 to resolve the potential areas of conflict between the national and district authorities in such areas as environmental permitting, AMDAL approval process, and others (ADB, 2005). The intention is to provide more emphasis on implementation at provincial levels.

Indonesian Fisheries Act No 31, 2004.
The Indonesian Fisheries Act provides significant responsibilities to MMAF and is likewise involved in strengthening environment-related legislation, recently particularly from a food safety perspective. Recent trade concerns with the European Union in particular have led to several initiatives to update legislation related to use of drugs and chemicals and overall environmental management of the aquaculture sector. Among recent initiatives include Good Aquaculture Practice and Good Hygienic Practice Decrees and guideline documents.

Scope of environmental assessment
The EIA procedure is defined in Government Regulation No.27/1999 and the Decree of the State Minister for the Environment No. 40/2000 on working procedures for the Commission for Appraisal of Environment Impact Analysis (2000). Applications for EIAs are filed with the national, regional or municipal commission of appraisal, depending on the location of the concerned activity. Activities affecting national security are assessed by the national commission. Applicants must prepare an environmental impact study, an environmental management plan and an environmental monitoring plan. The relevant authority must grant or deny the authorization within 75 days from the application, silence meaning approval. If the project is not implemented within three years from the EIA, the authorization is declared as expired.

According to the Ministry of Environment Decree No. 17, 2001, the requirement for EIA related to aquaculture is established based on project area size as follows:

- An EIA is required for the cultivation of shrimp/fish breeding ponds, exceeding 50 ha, with or without processing plant.
- For cage farms, including floating cages and pen system culture in freshwater lakes, an EIA is required if the area is more than 2.5 ha, or more than 500 cage units.
- For marine cage farms, including floating cages and pen system culture in coastal areas, an EIA is required if the area is more than 2.5 ha, or more than 1 000 cage units.

Small-scale farms below these sizes are exempt. As most of the aquaculture farms in Indonesia are small-scale, the majority of farms in inland and coastal waters are not subject to EIA, although they are subject to other licensing/permitting requirements, as well as voluntary measures such as Good Aquaculture Practice. There is no use of Strategic Environmental Assessment to date. The EIA requirement also does not cover all forms of aquaculture, for example seaweed farming, hatcheries and other land and sea-based activities appear not to be covered, although they are by licensing requirements.

New farms versus operational farms
EIA is only applied to new farms, and not to farms that are expanding in size.

Public participation and information disclosure
The AMDAL process has no provision for public review, except provision for participation of NGOs as community representatives on AMDAL review committees. As noted in the ADB review (ADB, 2005), in terms of accessing information, it has been extremely difficult for the public to participate in decisions affecting the environment. As far as is known, EIA documents are also not disseminated to local communities.

Environmental monitoring
Environmental impact monitoring should be specified in the EIA, according to the environmental management law. In practice, there appears to be limited environmental monitoring following EIA approval for most projects, although there are exceptions. For

example, the Asian Development Bank project "Earthquake and Tsunami Emergency Assistance Project" conducted an environmental screening process for all emergency assistance projects in the fisheries sector in the Province of Nanggroe Aceh Darussalam and the island of Nias during 2006 and 2007, followed by follow up environmental monitoring. Further implementation of environmental monitoring beyond closure of the project will depend on local government and private sector funds being available, which in many instances appear to be limited for small-scale aquaculture development.

Larger scale aquaculture projects, such as the big shrimp farm projects of Dipasena in south Sumatra do conduct regular environmental monitoring of water quality, and submit reports to local environmental agencies.

Voluntary instruments

There are an increasing number of mandatory and voluntary-based approaches to environmental management in Indonesia, issued in the form of Good Aquaculture Practice documents and guidelines. The Directorate General of Aquaculture and Ministry of Marine Affairs and Fisheries has recently issued Decrees concerning "Good Aquaculture Practice" (Indonesia, 2007a; 2007b) which are mandatory requirements, although at a very early stage of implementation. A major purpose of such documents is to promote improved hygienic practices in aquaculture, particularly for exported products, but the documents do contain issues of environmental concern where they relate human health (e.g. control of antibiotics).

TABLE 24
Recent Good Aquaculture Practice documents for aquaculture in Indonesia

Voluntary instrument	Origin	Scope
Good Aquaculture Practice	Directorate General of Aquaculture, MMAF	Hygienic practices for aquaculture, with an emphasis on export products (shrimp, tilapia, milkfish, catfish)
Good Hatchery Practices	Directorate General of Aquaculture, MMAF	Hatchery practices with an emphasis on chemical and drug residue free production

The MMAF is also in the early stages of elaborating a system for certification of aquaculture farms, initially with an emphasis on intensive shrimp farms. This has been prompted in particular by concerns in EU export markets over drug residues in aquaculture products.

Practices

Environmental assessment

Limited information was available on environmental quality standards, objectives and methods used to determine environmental impacts in EIAs. Carrying capacity models are in the early stages of development for marine fish cage farms in Indonesia (Halide, Brinkman and McKinnon, 2008), but these are yet to be put into practical use in EIA, or regional planning, within the given institutional framework. Rachmansyah (2004) estimated the carrying capacity of Awarange Bay in South Sulawesi around 36 tonnes of fish biomass under 28 ha potential area for marine fish farming, using carrying capacity models. The carrying capacity model is also available for review online, with the intention of encouraging its wider use and development (Australian Institute of Marine Science, 2008).

Environmental monitoring

Water quality standards in Indonesia are available, divided into two categories:

1. National Water Quality Standards (NWQS);
2. Local Water Quality Standards (LWQS) that may be established to support and protect the designated uses of water at a specified area.

A Local Water Quality Standard for a particular parameter may be different from the National Water Quality Standard for that same parameter. The concentration may be either higher or lower, depending on local conditions. If the waterbody has a number of uses, the Local Water Quality Standards applied to it are for the most sensitive use.

National Water Quality Standards have been established for aquaculture as noted below.

Water quality standards for shellfish farming are established by Decree of the Minister of Marine Affairs and Fisheries No.Kep.17/MEN/2004 on Indonesian Shellfish Sanitation System (2004). This shellfish sanitation system includes the classification of "shellfish growing areas" in four categories, according to the microbiological quality of waters:

- Class A, permissible areas;
- Class B, permissible areas under certain conditions;
- Class C, limited areas;
- Class D, off-limit areas.

Such areas may be closed and reopened, after a re-evaluation procedure confirming the deterioration or improvement of the quality of waters with regard to shellfish breeding. Such a decision is taken under the responsibility of MMAF. Aquaculture Development Centers under the Directorate of Aquaculture, known as Technical Implementing Units, which are the major institutions implementing the monitoring programmes (Sukadi, 2006).

Concerning wastewater discharge, two texts are worth mentioning, neither of which, however, makes reference to aquaculture effluents. The discharge of effluents and waste into marine waters is covered by Government Regulation No.19/1999 re Control over marine contamination and/or damage (1999). In addition, the Decree of the State Minister for Environmental affairs No.110/2003 on the Guidelines on stipulation of accommodating capacity of load of water pollution in water sources (2003) proposes two mathematic models for the assessment of pollution capacity of waterbodies and watercourses (FAO, 2006-2008 NALO Indonesia).

Personnel and costs

The cost of preparing the EIA is borne by the project developer. No information on actual costs for conduct of an EIA, or follow up environmental monitoring, was available.

Difficulties and constraints in practice

The difficulties and constraints in practice include:

- limited follow up monitoring, related to both funding concerns and unclear feedback to improved management;
- limited capacity, particularly at local levels for appraisal of EIA;
- lack of enforcement of EIA procedures;
- lack of coverage of small-scale farmers;
- unclear institutional responsibilities.

Effectiveness

ADB (2005) notes that the effectiveness of implementation of the existing natural resource management regulations in Indonesia, including EIA, is in question for several reasons:

- the variety of national, provincial and district level organizations responsible for administering the administrative, legal and implementation aspects of the natural resources management sectors;
- lack of cross-sectoral coordination;
- understanding of laws and capacity to implement them in the district levels as a serious challenging problem.

These general constraints apply equally to the aquaculture sector, implying that a significant focus is required on building up the provincial and district level capacity for implementation of environmental management laws and regulations, and creating and sustaining cross-sectoral coordination efforts. Enforcement capability is also generally weak given that mandate/authority for enforcement is spread over multiple agencies with limited capacity. Inadequate implementation of spatial planning laws for example is widely accepted in Indonesia to have resulted in loss of coastal mangroves and resulted in growth of low yield fish ponds which are not captured by existing single project EIA systems.

Technical appropriateness

The lack of effective EIA measures suggested the need for significant improvement in the approach to EIA and aquaculture in Indonesia. The ongoing work on development of spatial planning approaches, linked to awareness raising and capacity building at local government level through ongoing DGA/ACIAR projects (McKinnon, 2007), may lead to improvements.

Use of data for improved performance of aquaculture

The data from EIA and monitoring is generally not used for improving the performance of aquaculture practices. The organization and sharing of data collected is very limited. The more market driven approaches related to implementation of Good Aquaculture Practice (GAP), certification and market access requirements might lead to improvements in the use of data to promote improved environmental management of aquaculture. However, substantial improvements in the organization of data within the implementing agencies, from local to central level, will be required to put in place an effective system for use of environmental data to improve performance of aquaculture practices.

Impact of EIA and monitoring on environmental protection

The use of EIA for larger farms has likely had some positive impacts on environmental protection at the local level, however, the data to evaluate these impacts is not available. The difficulties in use of EIA for small-scale aquaculture farmers (which make up the bulk of production for the aquaculture sector in Indonesia, and cumulatively can create significant environmental impacts), suggests that the impact of the EIA on overall environmental protection in the sector has been limited. The need for attention to improved environmental management measures involving the small-scale sector is emphasized.

Feedback and review

No effective feedback mechanisms within government structures exist for monitoring of on-farm improvements, for review of data and for facilitating management improvements, at the on-farm level, the level of farm clusters and at the sectoral level. The decentralization process has also made the system for such feedback more complicated. Improvements in information flow and relating such information flow to management decisions in a decentralized context are needed.

Perceptions of stakeholders

No detailed information is available on perceptions of stakeholders to the EIA procedures, although informal comments on EIA suggest that the process is viewed more as a legal formality than a management measure to improve performance of aquaculture investment. Private sector associations in Indonesia, are however, increasingly aware of food safety and market issues. For example, the Shrimp Farmers Association of Indonesia has been active in working with MMAF in the promotion of Good Aquaculture Practices.

Improvements

There are significant opportunities for improvement in the use of EIA, monitoring and related management measures to improve the environmental management of aquaculture in Indonesia:

- More coordinated multi-sectoral approaches, through more effective local level planning are needed, to prioritize natural resources management interventions, or impacts of different sectors, including aquaculture.
- Local capacity building is required. Devolution of authority at local levels requires a significant effort to improve the capacity at the local levels for implementation of better management of aquaculture. In a country as large as Indonesia, the devolution of authority to the local government and community groups for resources management and allocation decisions could be more effective than a centralized approach. Local government units and citizens were not involved in natural resource decision-making and management processes during previous highly centralized governments; limited capability is consequently left at the local levels. Capacity building is needed for the required human resources and institutional development to keep pace with the decentralization process and as aquaculture expands significantly in Indonesia as a government priority sector.
- Public participation in EIA procedures and access to information on EIA is presently limited and could be improved.
- Use of Strategic Environmental Assessment of farmer clusters or sectoral management plans.
- Integration of aquaculture into cross-sectoral resources planning. Because of the complexity and the many issues that must be addressed, environmental management of aquaculture should be integrated across habitats, governmental units and sectors. An integrated ecosystem approach would address linkages between development, human activities, biophysical processes and sectoral activities in both terrestrial and marine environments, although this will be difficult to implement in practice.
- Spatial land use planning can be an effective tool for achieving integration of environment, economic and social concerns into the policy and planning process; some new experiences are emerging from pilot projects involving marine aquaculture in Sulawesi, and fish cage culture in reservoirs in central Java. Such approaches should be further expanded and promoted.
- Private sector involvement in the management of coastal and inland resources should be promoted. There is increasing awareness of environmental issues in larger private sector enterprises, mainly as a result of trade related problems, and as such there is awareness and now growing opportunities to promote better environmental management in the sector. The government has recently adopted legislation to promote "corporate social responsibility" in the private sector, which may provide incentives for larger aquaculture businesses to adopt improved environmental and social management measures.
- The widespread promotion of voluntary measures such as codes of conduct, and similar sectoral management instruments, is recommended to encourage more pro-active environmental management in the private aquaculture industry. These approaches can be complementary to the EIA approach, together providing better coverage of environmental management across the sector.

JAPAN[10]

Requirements

Environmental impact assessment

The Basic Environmental Law (Japan, 1993) is the legal basis for Japanese environmental policies. The purpose of this law is to clarify the responsibilities of environmental conservation to the state, local government, industry and citizens. The law is intended to promote comprehensive and systematic policies for environmental conservation to ensure healthy and civilized living for present and future generations, as well as to contribute more generally to the welfare of mankind. Article 20 of this law refers to the execution of environmental impact assessment for activities such as alteration of land shape, construction of new structures and environmental conservation considerations based on the results of the EIA.

The Environmental Impact Assessment Law (Japan, 1997), implemented from 1999 and revised in 2005, sets forth procedures and contains other provisions designed to define the responsibilities of the government regarding EIAs and to ensure that EIAs are conducted properly and smoothly with respect to large-scale projects that could have serious environmental impacts. The law also prescribes measures to reflect the results of EIAs in implementation of such projects and in determining the content of such projects.

The Law does not directly refer to aquaculture. However, prefecture and city governments can set ordinances on EIA following the Environmental Impact Assessment Law (Japan, 1997), taking account of local conditions. Not all prefecture or city governments include aquaculture activities as mandatory to conduct EIA under their Ordinance. Forty-seven prefecture governments and 13 city governments have set their own ordinance for EIA, of which 21 have a requirement for EIA on agriculture, which under the definition of agriculture may include aquaculture (Ministry of Environment, 2006). Prefectures with important aquaculture industries have established EIA criteria for aquaculture farms. Scale or expansion of the farming area is one of the criteria for EIA requirement, for example a farm larger than 15 ha is required to conduct EIA in Okinawa prefecture, while the threshold is 50 ha for Hokkaido and Aichi prefectures.

In practice, no EIAs have been conducted for aquaculture, and environmental management responsibilities are largely delegated and assigned to the Fisheries Cooperative Associations (FCAs) under the Fisheries Law of Japan.

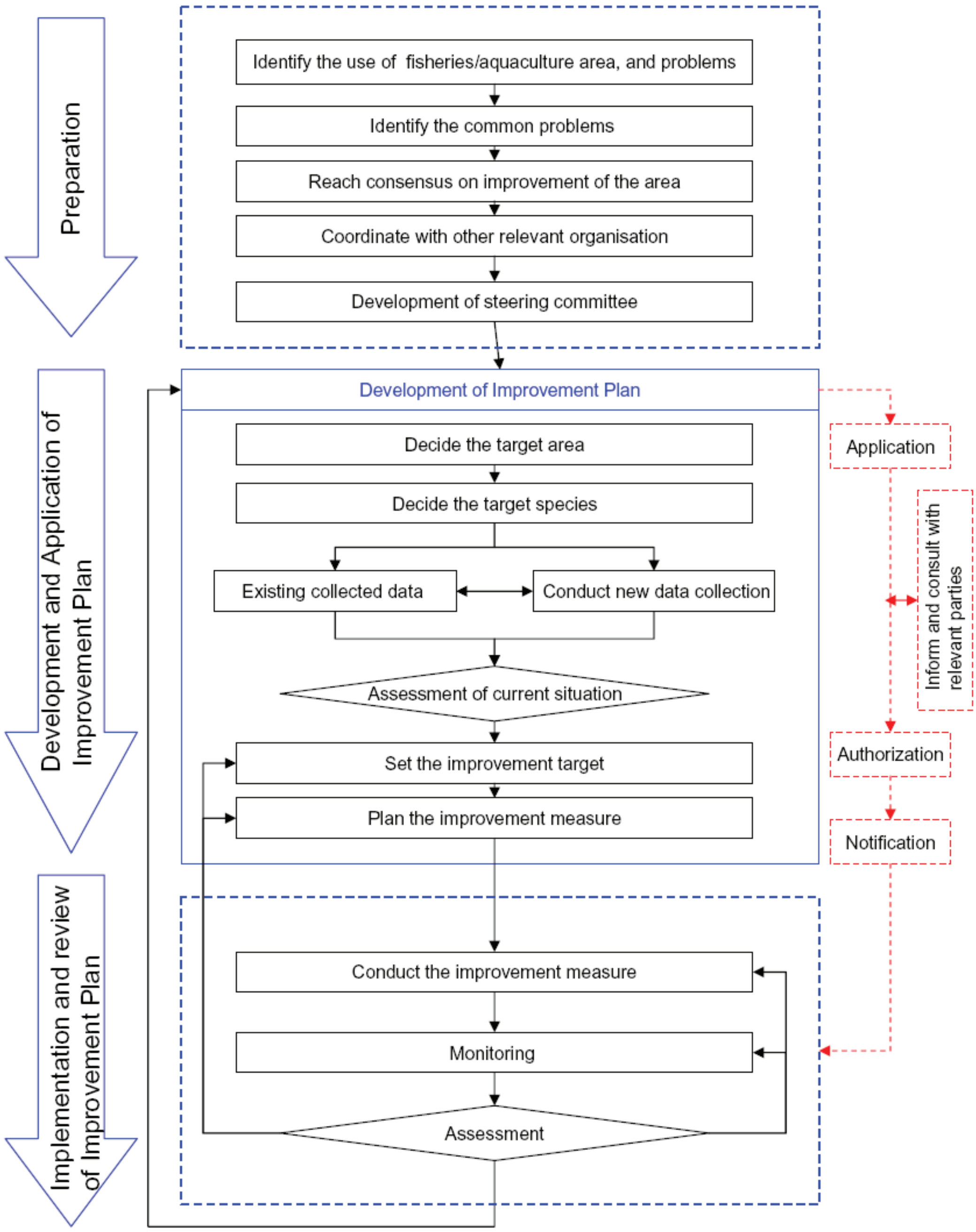
The Fisheries Law (1949, revised 1962) is the principal law for regulation of fisheries activities and is administered by Ministry of Agriculture, Forestry and Fisheries (MAFF), within which many regulatory tasks are delegated to prefecture governments (FAO, 2005-2008 NALO Japan). The Fisheries Law states that fisheries rights, including aquaculture, are granted by the prefecture governor to a fisheries cooperative association, which distributes rights among its members. Rights are exclusive to that member association (FAO, 2005-2008 NALO Japan, Yokoyama, Nishimura and Inone, 2007). Under this right, the FCA conduct management and evaluation of fisheries activities, including environmental assessment and monitoring related to aquaculture.

The Law to Ensure Sustainable Aquaculture Production (Japan, 1999) is the first law to specifically target aquaculture and is intended to reduce risks of aquatic animal diseases and to improve environmental conditions. The law requires individual FCAs, or multiple associations, to jointly develop and implement "Aquaculture Ground Improvement Programs (AGIPs)", and submit these programs to the prefecture government (Fig. 2). For example, Saroma-ko FCA, which manages scallop and Pacific oyster farms in Saroma-ko Lagoon in Hokkaido, instituted AGIP which

[10] Contribution by Hisashi Yokoyama and Koji Yamamoto

established voluntary regulations regarding water/sediment qualities, number and size of aquaculture facilities and production, method and frequency of monitoring farm environments, framework to facilitate the preservation of farm environments and so on. FCAs for fish farming by floating cages aquaculture such as Yusu FCA in Ehime Prefecture, major producer of red seabream, and Azuma FCA in Kagoshima Prefecture, major producer of yellowtail, established similar AGIPs. Particularly, the former FCA noted that producers should take dead fish away from fish cages and should report the number and size of dead fish and the cause of death to the FCA, while the latter FCA promoted polyculture in which fish and seaweed culture are integrated, and planting trees around the farm location.

FIGURE 2
Procedure for development, implementation and review of Aquaculture Ground Improvement Programme in Japan



Source: JFRCA (2007)

Within this national and prefectural framework of laws and policy, FCAs establish their own regulations regarding control and specific items of operation, such as the area, duration and methods of mariculture.

Land based aquaculture facilities that are not based on public waterbody do not require fisheries rights and therefore do not take part in FCAs or Aquaculture Ground Improvement Programs.

FCAs are also developed in major lakes and reservoirs where capture fisheries, aquaculture and leisure fishing are present. Due to its closed and hazard prone environment, the Law Concerning Special Measures for Conservation of Lake Water Quality (Clean Lake Law) (1984 revised 2004) was enacted to conserve lake environments by regulating activities discharging wastes or impacting the lakes. This law regulates surrounding domestic activities as well as agricultural activities such as cage aquaculture of carp, which had not been regulated by the conventional Water Pollution Control Law (1970). The Clean Lake Law regulates carp farms that have more than a 500 m^2 cage area, and respective prefectural governments set their ordinances to regulate management of those farms.

Administration and responsibilities

Table 25 summarizes the administrative responsibilities under the fisheries laws as related to environmental management of aquaculture.

TABLE 25
Administrative responsibilities for environmental management of aquaculture

Institution (s)	Responsibilities
Ministry of Agriculture, Forestry and Fisheries (MAFF)	Administration of Fishery Law.
Japan Fisheries Resources Conservation Association (JFRCA)	Establishes Environmental quality standards (EQSs) for aquaculture grounds. Provides guidance for the implementation of the Aquaculture Ground Improvement Programs (AGIPs).
Prefecture government	Grants licences to the FCA. Authorises the AGIPs
Fisheries Cooperative Association (FCA)	Links the central and prefectural governments to individual farmers. Implementation of official fisheries projects Manages day-to-day practices of farmer members.

Scope of environmental assessment

Accompanying Japan's rapid economic growth during the 1960s, the discharge of industrial wastes and sewage effluents resulted in eutrophication of coastal waters. Within the MAFF, the Fisheries Agency is responsible for preserving and managing marine biological resources and fishery production activities. The Fisheries Agency recognized eutrophication as a serious threat to inshore fisheries, and requested the Japan Fisheries Resources Conservation Association (JFRCA) to devise Environmental Quality Standards (EQSs) in inshore fishery grounds for assessment of the environments. In 1983, JFRCA established the 'EQSs at coastal fisheries grounds', based on three indicators of water quality (i.e. dissolved oxygen, chemical oxygen demand and acid volatile sulphides).

Japanese environmental legislation is closely tied to legal safeguards for coastal fisheries. Ten years after the EQSs were established, the Basic Environmental Law (Japan, 1993) was enacted, requiring the government to establish EQSs to be achieved and maintained in public waters to protect human health and conserve the living environment. Although not specific to aquaculture, the standards take into consideration the potential health hazards associated with the intake of listed substances through drinking water and/or fish and shellfish. In addition, bodies of water, including coastal waters, were classified based on water usage, and the EQS values were established for each class.

In Japan, the legislation framework was constructed fundamentally to protect fisheries and mariculture environments from sewage and industrial effluents. In the 1960s and 1970s, when fish farming had developed increasingly, most people including fish farmers, government officers and researchers did not recognize the need to assess fish farm environments before commencement of farming. Such tendencies have been continuing to 1999, when the Law to Ensure Sustainable Aquaculture Production was enacted. Even this law does not require an assessment of environments before the commencement of aquaculture.

Therefore, for most fisheries grounds in Japan there have been no cases of environmental impact assessments conducted prior to the establishment of aquaculture, and the scope of the 'environmental assessment' is focused on the monitoring of environmental parameters and evaluation of assimilative capacity.

New farms versus operational farms

To screen proposed investment and development of new aquaculture operations, the prefecture government will set up an *ad hoc* committee that consists of local government officials, FCA representatives and academia representatives. In the case of larger numbers of fishermen willing to conduct different types of aquaculture within a relatively large but sheltered location, special "Demarcated Fishery Rights" can be applied under the Fisheries Law (FAO, 2005-2008 NALO Japan; Yokoyama *et al.*, 2006).

Public participation and information disclosure

Public participation is emphasized in the EIA legislation for Japan. Regarding fisheries legislation and policies, the public are able to obtain administrative information from the MAFF Web site. Some information is available in electronic form via the web site, and other material only available as hard copy. There is also a government information portal (e-Gov, www.e-gov.go.jp), where administrative information for all ministries can be searched, including documents related to Aquaculture Ground Improvement Programmes (AGIP).

Environmental monitoring

In support of implementation of the Law to Ensure Sustainable Aquaculture Production (Japan, 1999), MAFF issued Basic Guidelines to Ensure Sustainable Aquaculture Production (Japan, 1999). These guidelines state the FCAs themselves should conduct regular environmental monitoring, amongst the other guidance for sustainable aquaculture production. More specifically, the initial analysis of existing aquaculture ground should be conducted during the AGIP's development process, broadly covering the ground condition, its changes over time, local characteristics, identification of environmental problems and internal and external causes. Although this system is based on voluntary activities, in the case the FCA does not utilize its aquaculture grounds in line with the basic guidelines, and the environmental conditions of its aquaculture grounds deteriorate, the prefectural governor may recommend that the cooperative association take necessary measures for improving aquaculture and re-evaluation of the AGIPs.

If the cooperative association does not follow the recommendation, the prefectural governor may make the environmental status of the FCA's fisheries area public. However, no such cases have arisen as yet. The main objective of the legislation is to change the farmer's mind as "the farm is located in public waters and does not belong to the farmer's property". Most FCAs have established AGIPs, which are starting to get the farmers' attention, and improve the aquaculture environment.

Voluntary instruments related to environmental assessment and monitoring of aquaculture in Japan are noted in Table 26. JFRCA (2007) published a manual for implementation of AGIPs for leaders of FCAs and administration officers, as well as for producing many brochures for farmers. Another instrument provided by academia is a personal computer program/software 'Kukai' (Nishihara, Miyazu, Kyoto) designed by Kadowaki (Kadowaki, 1992), which shows the optimum amount of feed based on data on environmental conditions, culture conditions and cultured fish.

TABLE 26
Voluntary instruments for environmental management of aquaculture

Voluntary instrument	Origin	Scope
Manuals for development and implementation of Aquaculture Ground Improvement Programmes	Japan Fisheries Resources Conservation Association (JFRCA)	Supporting document for assisting FCA to develop and implement the AGIPs
Personal computer software 'Kukai'	Kadowaki, Kagoshima University.	Calculating appropriate amount of fish feed depending on number of fish, fish size, DO content in seawater, water temperature, tidal cycle, etc.

Practices

Environmental quality standards

Abiotic and biotic components of aquaculture environments have been used as indicators for environmental monitoring of coastal fisheries grounds and aquaculture farms. The former includes chemical oxygen demand (COD), dissolved inorganic nitrogen and dissolved oxygen (DO) in water, and COD, ignition loss, total organic carbon, total nitrogen, total phosphorus and acid volatile sulphide (AVS) in the sediment. The latter includes the species composition and community parameters of macrofauna, microflora and microbial biomass. In 1983, JFRCA established EQSs at coastal fisheries grounds based on three indicators of water quality (*i.e.* dissolved oxygen, chemical oxygen demand and acid volatile sulphides) (JFRCA,1983). Shortly afterwards, the JFRCA proposed an "Organic Pollution Index" (JFRCA, 1985).

An environment is defined as slightly deteriorated when the effects of eutrophication begin to appear in the benthic community as indicated by the occurrence of organic pollution indicators and a decrease in species diversity. A highly deteriorated environment is one in which eutrophication has serious impacts on the benthic community, resulting in exclusive dominance of pollution indicators, a decrease in biomass and ultimately azoic conditions.

Dissolved oxygen is one of most important factors controlling life in aquatic organisms. The JFRCA recommends maintaining a DO of >6 mg/L in the bottom layer in coastal waters to ensure healthy growth of aquatic animals. A DO content of 4.3 mg/L was established as one of environmental quality standards for the minimum limit in inshore fisheries grounds, and a DO of <2.9 mg/L indicated critical conditions for survival of benthic animals. COD is closely correlated with the amount of organic matter in sediments. The JFRCA proposed >20 mg/g (dry sediment) and >30 mg/g of COD as EQS to indicate slightly deteriorated environments and highly deteriorated environments, respectively. These EQS values are widely adopted in Japan except in the northern part, where environmental deterioration seems to be less conspicuous than in central and southern parts of the country, even in areas with high COD values due to the low water temperatures. AVS is produced when organic matter decomposes under anoxic conditions. As the organic loading rate increases and de-oxygenation proceeds, the AVS content in sediments increases. The JFRCA proposed >0.2 mg S/g (dry sediment) and >1.0 mg S/g of as EQS to indicate slightly deteriorated and highly deteriorated environments, respectively. The Organic Pollution Index was first calculated from a selection of bottom quality oriented environmental factors, including COD, AVS, ignition loss, total nitrogen, total phosphorus and mud content of the sediment, the Shannon-Weaver's species diversity index of macrofauna (H'), and from a principal component analysis of the environmental data from ten representative enclosed areas

(JFRCA, 1985). Improvements have been made in the calculation methods, and several formulae composed of a reduced number of environmental factors (e.g. COD, AVS and mud content) have been proposed (JFRCA, 2000). The calculation methods and some problems are discussed in Ohwada (2001).

The Law to Ensure Sustainable Aquaculture Production (Japan, 1999) together with the Basic Guidelines to Ensure Sustainable Aquaculture Production (Japan, 1999) set environmental quality standards (EQS), which are regulations designed to protect the environment of the waterbody and/or aquaculture organisms, based on three indicators; (1) DO content of water in fish cages, (2) AVS content in the sediment and (3) the occurrence of macrofauna under aquaculture facilities (Table 27). The farm environments are identified as healthy when the values of these indicators are within the thresholds. At the same time, EQS for critical environments, which are used to signal that urgent countermeasures are necessary, have been identified.

The DO value for a healthy environment that was defined in the law is based on studies reporting that yellowtail requires more than 5.7 mg/L of DO for normal growth (Harada, 1978). The law also establishes 3.6 mg/L of DO as a minimum for mariculture farm environments, which represents an intermediate value between 2.9 mg/L of DO, which is at the extreme margin of survival for yellowtail, and 4.3 mg/L of DO, when feeding activity of yellowtail begins to decrease (Harada, 1978). The AVS standard in the sediments is based on the "Omori-Takeoka theory" (Omori, Hirano and Takeoka, 1994), as described in the following section. Recent studies, however, have found that it is difficult to determine the standard value by field investigations (Yokoyama and Sakami 2002; Abo and Yokoyama, 2003). In the law, the macrofaunal standard only specifies that benthic organisms should be alive. A healthy environment is identified in terms of the existence of live macrofauna throughout the year; while a critical environment is identified from the azoic conditions persisting during half a year or more. This EQS, although without biological basis, is convenient in terms of ease of monitoring by farmers. The procedures for environmental monitoring of aquaculture farms are specified by the Director General of the Japan Fisheries Agency in a Notification announced on 30 August 1999.

TABLE 27
Summary of monitoring requirements and criteria

Item	Indicator	Criteria for identifying healthy farms	Criteria for identifying critical farms
Water in cages	Dissolved oxygen	>5.7 mg/L	< 3.6 mg/L
Bottom environment	Acid volatile sulphide (AVS)	Less than the value at the point where the benthic oxygen uptake rate is maximum	>2.5 mg S/g dry sediment
	Benthos	Occurrence of macrobenthos throughout the year	Azoic conditions for >6 months

Environmental monitoring

The effects of organic matter loading from fish and shellfish farming on the environment have been the subject of considerable research since mariculture commenced in Japan, and there are many reports on water and sediment qualities and benthic fauna in and around fish farms. As aquaculture developed, year-after-year enrichment of the sediment has been reported from various localities in southwestern part of Japan (e.g. Arizono and Suizu, 1977; Kanbe, 1983; Hirayama, 1992; Yokoyama, 2002). There is a significant correlation between the seasonal and annual organic carbon load from the fish cages and AVS contents in the sediment (Pawar *et al.*, 2002). Tanigawa *et al.* (2007) monitored the sediment quality at a newly established fish farm site and found the increase in AVS contents from 0.03 mg S/g just before the start of farming to 0.46 mg S/g after 14 months.

Benthic animals are also clearly subjected to elevated levels of sedimentation and organic enrichment. Several studies have been conducted to monitor the mariculture environments (Tsutsumi, 1995; Yokoyama 2000; Sasaki and Oshino, 2004). These studies showed that the following are all typical effects of mariculture farming on the macrobenthos: a reduction in species richness and/or species diversity; a decrease in the number of large-sized species; the disappearance of echinoderms; the appearance of dense populations of the opportunistic polychaete *Capitella* sp.; and an increase in total macrofaunal abundance during the process of organic pollution and azoic conditions in the final stage.

Evaluation of the assimilative capacity

Assimilative capacity methods are to evaluate existing farm environments objectively and conduct aquaculture within the range of the assimilative capacity of their environments. In Japan, methods have been developed to assess the assimilative capacity of bays for mariculture. Omori *et al.* (1994) developed a model to determine the upper limit of fish production based on the oxidation of loaded organic matter. In this model, the rate of benthic oxygen uptake (BOU), defined as the *in situ* oxygen consumption by benthic animals and bacteria living in the sediment, was used as an indicator of the activity of the benthic ecosystem. They found a peak of BOU along a gradient of organic loading, and took this peak as an indicator of the maximum phase in the process of remineralisation. Based on this model, Takeoka and Omori (1996) presented a method to determine the assimilative capacity of fish farms using the AVS content in the sediment, because there is usually a positive correlation between the organic loading and AVS. This concept, the so-called "Omori-Takeoka theory", which states that AVS should be less than the maximum value of BOU at each fish farm, was adopted as one of EQSs in the Law to Ensure Sustainable Aquaculture Production.

On the basis of the model presented by Omori *et al.* (1994), Abo and Yokoyama (2003) developed a three-dimensional numerical model, which takes advection, dispersion, deposition and decomposition of organic matter from the mariculture system into account. They showed the upper limit of organic matter loading to grids of 100×100 m across the fish farm ground in terms of the equivalent weight of oxygen. Some measures currently being implemented are aimed at conducting mariculture within the range of the assimilative capacity of the surrounding ecosystem by siting farms in deeper, more seaward areas where the water current velocity is faster. In order to provide site selection guidelines for fish farming and to determine the upper limit of fish production, Yokoyama and colleagues proposed two indices based on studies on the macrofauna and chemical factors of the water and sediment. One index is 'ED' (Embayment Degree; after Yokoyama *et al.*, 2007), while the other index is 'ISL' (Index of Suitable Location; after Yokoyama *et al.*, 2004).

The equation for the Embayment Degree (ED) index is:

$$\mathbf{ED = (L/W)(20/Ds)(45/Dm)}$$

where L is the distance (km) from the bay mouth to the fish-farm site, W is the width (km) of the bay mouth, Ds is the water depth (m) at the fish-farm site.

The equation for the Index of Suitable Location (ISL) is:

$$\mathbf{ISL = DV^2}$$

where D is the water depth (m) at the fish-farm site and V is the time-averaged current velocity (m/s).

Personnel and costs
The responsibility for the Aquaculture Ground Improvement Program rests with the FCAs, who submit a report to the provincial government. The costs of developing the AGIPs and environmental monitoring programmes are covered by the FCAs. However for small FCAs, the costs are subsidised through the technical support of the prefectural fisheries station.

Difficulties and constraints
Presently, not all FCAs are capable of conducting environmental monitoring efforts due to technical and resource limitations. Only limited numbers of large scale and well-organized FCAs are conducting environmental monitoring efforts themselves, and the majority of the FCAs rely on public authorities such as the prefectural fisheries stations to fulfil the law and the guidelines.

Effectiveness
Technical appropriateness
In Japan, AVS is currently recognized as the most effective indicator for monitoring of the aquaculture environment. The absorbent-column method has been shown as a convenient method for measuring AVS. A procedure for the analysis of AVS is provided by Montani (2003). Recent studies regarding the AVS standard in the EQSs (Table 27 above) have found that it is difficult to determine the standard value through *in situ* investigations (Yokoyama and Sakami, 2002; Abo and Yokoyama, 2003). Abo and Yokoyama (2003) recommended use of the numerical model that was developed based on the Omori-Takeoka theory instead of *in situ* investigations for the practical application of the EQS. Various efforts have been made to re-evaluate and improve the standards and monitoring practices (Yokoyama, 2003; Tamura and Miyamura, 2004; Uede, 2007; Tanigawa, Yamashita and Koizumi, 2007; Yokoyama *et al.*, 2006; 2007). The EQSs, however, have remained the same since establishment of the guidelines in 1999.

Use of data for improve performance of aquaculture
Under the AGIPs, the intention is to utilize the environmental assessment and monitoring data, through analysis and evaluation of the aquaculture activities, such as location of the farm, species, culture density and feeding practices. In the case of well-organised FCAs, the data is analysed and considered as information for improvement and evaluation of effectiveness of planning and management. For the rest of the FCAs, prefectural fisheries stations are again providing the service to assist FCAs to effectively exploit the data. Whilst some data are used, it seems likely that further improvements in the use of data for management could be made. For example, Azuma FCA collects water quality data on a daily basis and also has been conducting assessment of water and soil quality twice a year for the whole aquaculture ground, in cooperation with Kagoshima University for the past 20 years (JFRCA, 2007). Saroma-ko FCA has monitored water and sediment qualities and fauna and flora in Saroma-ko Lagoon to maintain scallop and Pacific oyster farms (Maekawa, 2002). In recent years, the FCA has tried to reveal the material flow in the lagoon for estimating the upper limit of production. A project team that consists of the Mie Prefecture government, universities and public and civil research institutes has been formed to develop methods for the environmental remediation of Ago Bay, where the pearl oyster farming has been conducted for more than a hundred years. The team has confirmed the benefits of an automatic water quality measurement system and tidal flats that were rebuilt using enriched sediments under pearl farming rafts (Kokubu *et al.*, 2004).

Impact of EIA and monitoring on environmental protection

The benefits of the monitoring efforts are observed mostly in closed and intensive culture areas where eutrophication, (and associated red tides) as well as fish disease outbreaks were present. In these cases, environmental improvements have been made to reduce impacts on the environment, and improve environmental conditions for aquaculture.

Feedback and review

As a part of effective communication mechanism for feedback and review, MAFF welcome public comments at their Web site (MAFF, 2008) including categories for general inquiry, opinions regarding establishment or revision of the law, as well as archived comments. Recently, a review of the Law to Ensure Sustainable Aquaculture Production (Japan, 1999) was conducted and MAFF welcomed public comments on their Web site until early 2007.

Perceptions of stakeholders

For those places where aquaculture has been carried out for a long time and where environmental degradation and disease outbreaks have been experienced, there is strong consensus on the need for environmental management. In such places, the FCAs are well-organized and independently conducting environmental studies, as well as contributing to ongoing prefectural government studies. However, a large number of small FCAs often claim their production area is in a healthy condition and there are no strong incentives to conduct or improve environmental assessment or environmental monitoring.

Improvements

For aquaculture, EIA has not been formally implemented in the country as yet and environmental management is delegated to the local Fishery Cooperative Associations. Although the framework for environmental monitoring systems is stated by laws established by the responsible fishery authorities, with guidelines provided for implementation, the majority of the FCAs are not actively implementing environmental management measures, unless otherwise the area has gone through noticeable environmental degradation or disease outbreaks.

Possible improvements therefore include:

- Capacity building and awareness raising campaigns for FCAs by the public authorities such as ministries and prefectural fisheries stations.
- Development of clear and practical indicators and methods for FCAs to independently assess and manage their farming environment. It is necessary to review and improve the environmental indicators used, including development and modification of simulation programs considering topographical and oceanographic data.
- Investigations have shown that locating culture facilities in deep, offshore (near bay mouth) areas, is optimal for sustaining high production. This approach requires a large amount of investment for building facilities that are able to withstand strong winds and waves. Most mariculture in Japan is conducted in inshore, sheltered areas on a small-scale family-type operation often staffed by aged workers. It is necessary to integrate small-scale farming into more large-scale, intensive industry for environmentally responsible and sustainable mariculture.
- Development of market incentives to improve environmental management of aquaculture areas. Marine Stewardship Council (MSC) labelled capture fisheries products have started appearing in Japanese markets, but there is no such scheme as yet available for aquaculture products. Collaboration with producers (FCAs) and other stakeholders such as NGOs and certifiers may be one way for the industry to move towards more sustainable aquaculture production.

MALAYSIA[11]

Requirements

Environmental impact assessment

Under the Malaysian constitution, the use of land and water resources is under the jurisdiction of the respective states. Hence, each state is empowered to enact land law and policy independently. Most of the federal law (e.g. environmental and fisheries law) has universal application to all states, except Sabah and Sarawak. Sabah and Sarawak are members of the Federation, but some constitutional safeguards give them a greater degree of autonomy than the other states. Sabah and Sarawak each have state laws covering land, forestry, protected areas, wildlife, inland fisheries and aquaculture.

Although the Environmental Quality Act (EQA) was enacted in 1974 as the major federal environmental law in Malaysia, it was not until 1987 that the environmental impact assessment procedures were introduced under the EQA. The EIA is required for some 19 categories of activities prescribed under the Environmental Quality (Prescribed Activities) (Environmental Impact Assessment) Order 1987. In Sabah, the EIA system was initiated under the Conservation of Environment Enactment 1996 and the Conservation of Environment (Prescribed Activities) Order 1999. In view of new challenges in environmental management, these enactment and order were replaced by the Environment Protection Enactment 2002 and Environment Protection (Prescribed Activities) Order 2005, and came into force on the 3 January 2006.

In Sarawak, the Natural Resources and Environment Ordinance 1993 (amended in 1997) stipulates the statutory requirement for Environmental Impact Assessment (EIA) for development activities having impacts on the environment. The Natural Resources and Environment (Prescribed Activities) Order was enacted in 1994 and amended in 1997.

Aquaculture development is identified as one of the prescribed activities in environmental law in Malaysia. Table 28 summarizes prescribed activities related to

TABLE 28
Prescribed activities related to aquaculture development in EIA Order in Malaysia

State	Legislation	Prescribed activities required EIA report	Prescribed activities required proposal for mitigation measures report
All States in Peninsular Malaysia	• Environmental Impact Assessment Order of 1987 (Prescribed Activities)	• Aquaculture project which involves an area of more than 50 ha	
Sarawak	• Natural Resources and Environment (Prescribed Activities) (Amendment) Order 1997	• Conversion of mangrove swamps into industrial, commercial or housing estate exceeding 10 ha in area • Creation of lakes, ponds or reservoirs for the rearing of fish or prawn exceeding 50 ha in area, which may pollute inland water or affect sources of water supply • Fish culture and other forms of fishing on a commercial scale which involve the setting up of fishing appliances and equipment in the rivers or water courses, which may endanger marine or aquatic life, plants in inland waters or erosion of river banks	
Sabah	• Environment Protection Enactment (Prescribed Activities) (Environmental Impact Assessment) Order 2005	• Conversion of wetland forests into fisheries or aquaculture development covering an area of 50 ha or more • Creation of lakes or ponds for fisheries or aquaculture development covering an area of 50 ha or more	• Conversion of wetland forests into fisheries or aquaculture development covering an area of 10 ha or more but less than 50 ha • Creation of lakes or ponds for fisheries or aquaculture development covering an area of 10 ha or more but less than 50 ha

[11] Contribution by Tan Kim Hooi.

aquaculture development in EIA Order in Peninsular Malaysia, Sabah and Sarawak. Generally, EIA is mandatory for aquaculture projects with an area of more than 50 ha. However, the EIA Order in Sabah and Sarawak also contain additional provisions. An EIA report is also mandatory for conversion of mangrove swamps into industrial development including aquaculture projects in Sarawak. In Sabah, a proposal for mitigation measures report is required for aquaculture development covering an area of 10 ha or more but less than 50 ha.

In addition to the requirement of environmental impact assessment, licensing of aquaculture premises and culture systems is mandatory under the Fisheries Act 1985, Sarawak State Fisheries Ordinance 2003, and Sabah Inland Fisheries and Aquaculture Enactment 2003. Other relevant legislation pertaining to aquaculture development is the National Land Code 1965, which provides provisions to the Land Office for leasing of state land as the Temporary Occupation Land (TOL) for development purposes including aquaculture development. The holder of a TOL is given a temporary right to occupy the land and the right may be renewed subject to sub-section 93. The Land Office can impose certain conditions/prescriptions on the development of the land.

Administration and responsibilities

Table 29 shows the relevant administrative institutions and their roles in aquaculture development in Malaysia. The administration of EIA Orders in Peninsular Malaysia, Sabah and Sarawak is the responsibility of Department of Environment (DOE), Environment Protection Department (EPD) and Natural Resources and Environment Board (NREB), respectively. For prescribed activities, no development activity shall be carried out or commenced until the EIA report required to be submitted to the above mentioned authorities is approved and the authorities have given permission in writing for such activities to be undertaken or commenced. In Malaysia, EIA studies are carried out by experts or consultants who have been duly registered and approved by the authorities. The authorities maintain an environmental consultant reference list and environmental laboratory reference list of all of these environmental experts or consultants. The list of registered consultants is available for public review.(DoE – Malaysia, 2008a).

Aquaculture premises and culture systems are licensed by Department of Fisheries Malaysia (DOFM), Sabah Fisheries Department and Inland Fisheries Division of Sarawak Department of Agriculture. For prescribed activities, the license will only be issued by the fisheries authorities after the submission of an approved EIA report. The aquaculture license also contains several terms and conditions to be strictly adhered to by the operators for the sustainability of the aquaculture industry. These terms and conditions include pond design, farm layout plan, water quality management, environmental management and others. Failure to comply will incur the risk of being fined or having a license revoked.

Public participation and information disclosure

Public participation is required under federal EIA procedures in Malaysia, although requirements for participation may be lessened under some state laws. Some detailed EIA reports, and a list of EIA reports approved and under review, are available on the web site of the Department of Environment (DoE – Malaysia, 2008b).

Scope of environmental assessment

The EIA procedure adopted in Malaysia consists of three major steps, as follows:

1. preliminary assessment of all prescribed activities;
2. detailed assessment of those prescribed activities for which significant residual environmental impacts have been predicted in the preliminary assessment;
3. review of assessment reports.

TABLE 29
List of relevant institutions and their roles in aquaculture development in Malaysia

State	Institution	Legislation	Provisions / Responsibilities
All States in Peninsular Malaysia	Department of Environment	• Environmental Quality Act 1974 • Environmental Impact Assessment (EIA) Order of 1987 (Prescribed Activities) • Environmental Quality (Sewage and Industrial Effluents) Regulations 1979	• Prescribed activities (EIA) • Monitoring and enforcement in the post-EIA • Prohibition, restriction and control of pollution • Monitoring of river pollution and water quality
	Department of Fisheries Malaysia	• Fisheries Act 1985 • Fisheries (Marine Culture System) Regulations 1990 • Fisheries (Cockles Conservation and Culture) Regulations 2002	• Implementation of aquaculture development zone • Aquaculture licensing • Enforcement and monitoring of aquaculture premise based on conditions imposed in the permit or license • Import and export of fish
Sarawak	Natural Resources and Environment Board, Sarawak	• Natural Resources and Environment Ordinance 1993 • Natural Resources and Environment (Prescribed Activities) Order 1994 • Natural Resources and Environment (Prescribed Activities) (Amendment) Order 1997	• Prescribed activities (EIA) • Monitoring and enforcement in the post-EIA • Prohibition, restriction and control of pollution • Monitoring of river pollution and water quality
	Inland Fisheries Division, Department of Agriculture, Sarawak	• State Fisheries Ordinance 2003	• Aquaculture licensing • Enforcement and monitoring of aquaculture premise based on conditions imposed in the permit or license
	Sarawak River Board	• Sarawak Rivers Ordinance 1993	• Monitoring of river pollution and water quality
Sabah	Environment Protection Department, Sabah	• Environment Protection Enactment 2002 • Environment Protection Enactment (Prescribed Activities) (Environmental Impact Assessment) Order 2005	• Prescribed activities (EIA) • Monitoring and enforcement in the post-EIA • Restrictions on discharge of pollutants into water • Restrictions on activities affecting vegetation • Monitoring of river pollution and water quality
	State Fisheries Department, Sabah	• Sabah Inland Fisheries and Aquaculture Enactment 2003	• Implementation of aquaculture development plan • Aquaculture licensing • Enforcement and monitoring of aquaculture premise based on conditions imposed in the permit or license • Import and export of fish • Transportation of fish from peninsula Malaysia and Sarawak to Sabah, and *vice versa* • Control of fish diseases in aquaculture premise
Local	District Land Office	• National Land Code 1965	• The leasing of state land as the Temporary Occupation Land (TOL) for development purposes including aquaculture development.

The scope of environmental assessment should include all relevant aspects of the environment.

As noted above, the requirement for conduct of an EIA depends on the size of the proposed aquaculture farm and farms covering smaller areas are not subject to an EIA. Sea-based aquaculture farms (marine fish farms, seaweed farms) are also not included. Environment impacts are to some extent controlled for smaller farms (in inland and coastal areas) by simpler licensing procedures. The use of codes of practices (CoPs) is also being promoted by the Department of Fisheries Malaysia to encourage more environmentally sound aquaculture planning and management.

No strategic environmental assessment is applied to aquaculture plans, although informal environmental assessments have been conducted in association with preparation of zoning plans for aquaculture development in some states of Malaysia. For example, the preparation of a master plan for aquaculture development in Sabah included an environmental assessment of the proposed aquaculture activities in Sabah and potential aquaculture zones (Rayner, 1998).

Review of EIA reports is carried out internally by the Department of Environment (DOE) with assistance from the relevant technical agencies for preliminary assessment reports and by an *ad hoc* review panel for detailed assessment reports. Recommendations arising out of the review are transmitted to the relevant project approving authorities for consideration in making a decision on the project. According to the DOE's Client Charter, the periods allocated for a review of a term of reference and EIA report are as follows:

- Preliminary EIA report – five weeks;
- Terms of Reference for the preparation of detailed EIA Report – four weeks;
- Detailed EIA report – 12 weeks.

The DOE maintains a list of experts who may be called upon to sit as members of any review panel established. The selection of the experts depends on the areas of environmental impacts to be reviewed.

New farms versus operational farms

In practice, EIA is only conducted on new farms.

Environmental monitoring

The process of environmental impact assessment includes preparation of an environmental management plan, and identifies requirements for an environmental monitoring plan, specified by DOE to include the following:

- baseline studies for air, water and noise prior to the earthwork for data comparison during future monitoring;
- to identify and justify sampling stations for air, water and noise (on map);
- effluent discharge point must be identified and reported;
- frequency of monitoring;
- sampling method for air, water and noise.

To ensure compliance by project proponents, the authorities mobilize its officers to carry out monitoring and enforcement activities at project sites. The authorities may seek to compound offences for anyone for committing compoundable offences. In the serious case where there is low or no compliance, a stop work order may be issued by the authorities.

The monitoring of water quality of rivers and coastal marine waters is mainly done by environment agencies. Other agencies involved in monitoring of water quality (on a case by case basis) are fisheries research institutes, the Sarawak River Board and the Drainage and Irrigation Department.

Voluntary instruments

The Malaysia Aquafarm Certification Scheme is a voluntary scheme managed by the Department of Fisheries Malaysia for aquafarmers to promote good farming practices, *i.e.* more responsible and environmental friendly practices at the farm level to ensure product quality and safety, consistency in production and remain competitive in the global market. Important elements incorporated into the scheme are ISO 9002, SSOP (Standard Sanitary and Operating Procedures), Product Standards and Specifications, compliance with the Aquaculture's Code of Practice and Good Aquaculture Practices (DoF - Malaysia, 2008) and other terms and conditions as determined by the Department of Fisheries Malaysia. The farm categories covered by the scheme include:

- shrimp farming in brackish water ponds;
- freshwater fish in cages/pens;
- marine finfish in cages/pens;
- freshwater fish in ponds/tanks;
- marine finfish in ponds/tanks.
- marine finfish/shrimp hatcheries;
- freshwater fish/prawn hatcheries;
- molluscs culture (on-bottom, rafts/racks);
- ornamental fish.

One of the objectives of the voluntary scheme is to improve the product safety and quality and "to make the industry more responsible, more eco-friendly to ensure sustainable development for the future". The certification is provided by the DOF. Farms are required to be of suitable size, productive, competitive and manageable, specifically:

- for shrimp farms, a minimum 5 ha EFA (Effective Farmed Area), or a minimum production of 50 metric tonnes/year;
- for tilapia in net floating cages a minimum size of 3 600 m² EFA, OR a minimum number of 100 cages (minimum dimension of 6'x 6'), OR a minimum production of 150 metric tonnes/year.

The scheme is presently voluntary, although DOF Malaysia plans for it to become mandatory.

Practices

Environmental assessment

The scope of environmental assessment and some suggested methodologies are provided in the Department of Environment "EIA Guidelines for Fishing Harbours and/or Land Based Aquaculture Projects" (DoE – Malaysia, 2008c). Environmental quality objectives are available, for water quality in inland and coastal waters of Malaysia, which are used to assess impacts on water quality.

Environmental monitoring

Environmental monitoring is required as a follow up to EIA and the details are required to be specified in the environmental management plan. Responsibilities for monitoring are with the developer, but government may also conduct monitoring to verify compliance. The federal and state government also carries out regular monitoring of marine and inland waters, although not specifically targeted at aquaculture.

The Department of Environment has been conducting monitoring of rivers since 1978, primarily to establish the status of water quality, detect changes and identify pollution sources; a total of 927 manual sampling stations are located within 120 river basins throughout Malaysia. Water quality data is used to determine the water quality status whether it is in the clean, slightly polluted or polluted category and to classify the rivers in Class I, II, III, IV or V based on the Water Quality Index (WQI) and Interim National Water Quality Standards for Malaysia (INWQS) every year. WQI is computed based on six main parameters:

- Biochemical oxygen demand (BOD);
- Chemical oxygen demand (COD);
- Ammoniacal nitrogen (NH_3N);
- pH;
- Dissolved oxygen (DO);
- Suspended solids (SS).

Other parameters such as heavy metals and bacteria are measured in some rivers. Automated water quality monitoring is also conducted in selected locations (DoE – Malaysia, 2008d). Marine environmental monitoring is also conducted by government authorities throughout Malaysia. Surface and marine water standards are also available for classification of water quality and determining impacts of effluent discharge. The standards are available on the Department of Environment web site (DoE – Malaysia, 2008a).

Personnel and costs

The costs of EIA and monitoring are to be paid for by the developer.

Difficulties and constraints in practice

A number of other EIA issues and problems have been identified in Malaysia (Harun, 1994), and these are comparable to those in other developing countries in the region:

- lack of awareness of the strength of EIA as a planning tool. Many still perceive EIA as a "stumbling block" to development;
- perception that carrying out an EIA study would delay project approval and implementation;
- EIA not carried out prior to final project design, so that issues such as siting and technology are not considered;
- lack of base-line data on environmental quality;
- poor prediction of impacts;
- limited public participation.

The absence of a framework for environmental planning at a regional (catchment or coastal) level is also considered a major constraint on the effectiveness of the federal as well as state EIA procedures. Because EIA is administered essentially as a project-based tool, its ability to anticipate and manage cumulative impacts is also limited. The other major drawback of the current dual EIA procedures is that most types of aquaculture, particularly small-scale farms, fall outside the formal requirements for EIA. The environmental management requirements associated with these farms are however increasingly being considered through the licensing system, and the promotion of voluntary codes of conduct and certification schemes. Voluntary codes of practice and good aquaculture practice schemes are therefore becoming more important as tools to address potential environmental impacts and improve environmental management of the sector.

Effectiveness

Technical appropriateness

The methods used for EIA of aquaculture projects in Malaysia are considered appropriate, with technical capacity being available in many Malaysian EIA consulting firms for coverage of major environmental issues in aquaculture. The focus on individual project EIAs for large projects, rather than on strategic planning of aquaculture, limits the effectiveness of EIAs as an overall environmental management tool.

Use of data for improved performance of aquaculture

To date, it appears that EIA and environmental monitoring data have been used only in a limited way in improving environmental performance of aquaculture. Most of Malaysian aquaculture farms fall outside the formal requirements for EIA. On-farm monitoring is encouraged under the voluntary code of practice and good aquaculture practice, and is required for certification.

Impact of EIA and monitoring on environmental protection

The main emphasis of the Department of Fisheries Malaysia is to promote environmental improvements, including food safety aspects of aquaculture production, through encouraging industry to adopt codes of conduct and good aquaculture practice guidelines.

Feedback and review
No information is available on this subject.

Perceptions of stakeholders
The perceptions of stakeholders contacted informally suggest that EIA, whilst important for larger scale aquaculture development, as applied, has had limited impact on the environmental management of the aquaculture industry. The larger number of small-scale farmers, currently outside of existing EIA requirements limits the effectiveness of EIA as a sectoral environmental management approach.

5.6.4 Improvements
The main emphasis of the Department of Fisheries Malaysia is to promote environmental management improvements from a sectoral perspective, including food safety aspects of aquaculture production, through encouraging industry to adopt codes of conduct and good aquaculture practice guidelines.

THE PHILIPPINES[12]

Requirements
Environmental impact assessment
The apex of the hierarchy of laws is the 1987 Constitution which provides the general guidance for the management and use of all natural resources in the Philippines. All laws, rules, regulations and other acts of the government therefore, must be consistent with the provisions of the Constitution. In case of inconsistencies, the provision of the Constitution shall govern (Art. 7, the Civil Code of the Philippines).

Second in importance to the Constitution are all laws, called the Republic Acts (RAs), passed by the Congress of the Philippines. Prior to the enactment of the 1987 constitution, however, the President of the Philippines exercised legislative powers through issuance of Presidential Decrees (PDs) and Executive Orders (EOs). These PDs and EOs also have the force and effect of a law unless amended or repealed by a Republic Act under the 1987 Constitution. A common norm in interpreting laws with related and/or conflicting provisions is to use either the most recent law or the special law, whichever is applicable. Treaties entered into by the Philippines and ratified by Congress also have the same force and effect of law. The Executive Branch of government is responsible for implementation of all laws and treaties. To carry out this task, appropriate EOs or Administrative Orders (AOs), memoranda or circulars are issued. EOs or AOs are signed by the President of the Philippines. The various Department Secretaries issue Department Administrative Orders (DAOs) in matters pertaining to their own departments.

At the local level, Local Government Units (LGUs) have certain legislative powers that are exercised through their respective local legislative councils or “sanggunian”. LGUs cannot promulgate ordinances which violate the Constitution, any existing laws passed by Congress, or executive issuances promulgated by the Executive Branch.

Environmental laws relating to aquaculture in the Philippines emanate from four major fundamental laws of the land, the Presidential Decrees (PD)1151, PD 1586, the Republic Act (RA) 7160 (Local Government Code of 1991) and the most recent Fisheries Code of 1998 (RA 8550). Interpretation, application, implementation and enforcement of these laws, however, needs a basic understanding of the country’s governance structure as a key step in appreciating the relatively complicated hierarchy of executive and legislative mandates distributed among the many different government implementing and enforcing agencies (Table 30).

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[12] Contribution by Nelson Lopez and Patrick White

The first policy dealing with the Environmental Impact Statement System was first introduced in 1977 by Presidential Decree (PD) No. 1151, known as the "Philippine Environmental Policy". Section 4 explicitly requires *"all agencies and instrumentalities of the national government, including government-owned and controlled corporations, as well as private corporations, firms and entities to prepare an EIS for every action, project or undertaking which significantly affects the quality of the environment."* Presidential Decree 1586 formally established the Philippine EIS system in 1978. Consistent with PD 1151, it states that Environmentally Critical Projects (ECPs) and projects within Environmentally Critical Areas (ECAs) require the submission of an EIS. Section 4 provides that *"no person, partnership or corporation shall undertake or operate any in part such declared ECP or project within an ECA without first securing and Environmental Compliance Certificate (ECC)".* Sanctions are provided for its violation. PD 1586 was implemented through the issuance of administrative regulations and guidelines. The Presidential Decree 1586 addresses aquaculture both directly and indirectly. It identifies certain types of aquaculture as ECPs, e.g. inland-based fishery projects with water spread area from 300 m^2 to 10 ha, and ECAs, *i.e.* lakes and coastal waters, and in theory at least aquaculture development in these locations should be subject to environmental assessment.

The issue of Department Administrative Order No. 96-37 1996 by the Department of Environment and Natural Resources (DENR) further strengthens the EIS system in the Philippines. This was followed by Administrative Order No. 42, issued by the Office of the President to rationalize its implementation and to address the deficiencies in the EIS system and make it a more effective means of environmental management. In 2003, DAO 2003-30 was issued to further streamline the EIS system and strengthen its implementation process. The provisions contained herein, are the basis for the EIS system being followed at the present time. Under Section 1, Article 1, it is stipulated that *"consistent with the principles of sustainable development, it is the policy of DENR to implement a system-oriented and integrated approach to the EIS system to ensure a rational balance between socio-economic development and environmental protection for the benefit of present and future generations."* The implementing agency is the Environmental Management Bureau (EMB) under the DENR.

There are in addition a number of relevant environmental measures addressed in the Philippine Fisheries Code. The code reiterates the mandates of the Local Government Code and provides the broad framework for the use, conservation and management of fisheries resources. The Fisheries Code stipulates specific provisions in aquaculture including the issue of licensees and permits for certain activities. As an implementing order pursuant to Section 47 of RA 850, the Department of Agriculture through the Bureau of Fisheries and Aquatic Resources (BFAR) issued Fisheries Administrative Order 214 series of 2001 (FAO 214) or the Code of Practice for Aquaculture that outlined a wide range of measures intended to strengthen environmental assessment and management of the aquaculture sector, including specific reference to the EIS procedures and environmental assessment.

Administration and responsibilities

Regulation of aquaculture is performed primarily by the Department of Agriculture's Bureau of Fisheries and Aquatic Resources (DA-BFAR) and the LGUs. The former exercises direct authority over public lands, governed by fishpond lease agreements and national waters beyond the 15 km limit of municipal waters. Additionally it may exercise general rule-making and standard-setting functions implementing the Fisheries Code, which allows it to exercise general supervision over the LGUs in their exercise of jurisdiction over aquaculture activities within their respective territories.

LGU regulatory authority is governed by the Fisheries Code as well as certain provisions of the Local Government Code. This regulatory authority springs primarily from its licensing and land use planning jurisdiction, as well as some environmental controls granted under environmental laws. The LGUs have the key role and responsibilities to manage impacts of development and pollution within their jurisdictional area, within the framework and guidance provided by legislation and policy established at the national level. The LGU has a critical role in ensuring that all development projects within its jurisdiction that are either ECPs or projects in ECAs are subjected to the EIA review process.

The Department of Environment and Natural Resources also plays an important role in the regulation of aquaculture, though indirectly, on account of its jurisdiction over various aspects of environmental management. The "Environmental Impact Statement Policy" designates the DENRs Environmental Management Bureau (EMB) and the DENR Regional Offices as implementing agencies. EMB is responsible for review and issuance of Environmental Compliance Certificates for ECPs. The DENR Regional Offices reviews and issues ECCs for projects located in ECAs.

A joint Department of Agriculture-DENR Memorandum Order No. 01 of 2001 was implemented to promote better coordination of environmental management in the fisheries sector, including aquaculture.

The main institutions and their roles in environmental assessment and management of aquaculture development in the Philippines are summarized in Table 30.

TABLE 30
Relevant institutions and their roles in aquaculture development in the Philippines

Institution	Legislation	Provisions / Responsibilities
Department of Environment and Natural Resources (DENR)	Philippines Environmental Policy, 1977, PD 1151 Environmental Impact Statement Policy, PD 1586	• Prescribed activities (EIA) • Environmental management bureau of DENR as implementers of EIS policy • Issuance of Environmental Compliance Certificate through regional DENR office • Enforcement and monitoring jointly with BFAR and LGU as members of the Multipartite Monitoring Team (MMT)
Bureau of Fisheries and Aquatic Resources (BFAR) of Department of Agriculture	Fisheries Code of 1998, RA 8550	• Implementation of fisheries code, including environment related aspects • Provisions for aquaculture licensing of some activities (fish pond lease agreements, national waters >15 km from shore)
Local Governing Units	Republic Act RA 7160 and Local Government Code of 1991	• Management impacts of development in jurisdiction • Provisions for certain aquaculture licensing (pens, cages within the municipal waters, 15 km from the shoreline).

Public participation and information disclosure

The World Bank supported SEPMES-PEISS Project, managed by the Environmental Impact Assessment and Management Division (EIAMD) has recently prepared a handbook on multi-stakeholder participation in the EIA process in the Philippines (Tuyor *et al.*, 2007). Other national guidelines also emphasize the importance of public consultation although in practice it appears that the level of consultation is probably limited and it is generally recognized that participatory procedures in the EIA process should be improved.

The Code of Practice for Aquaculture (see below) also includes reference to aquaculture data management and creation of a database on environmental, social and land use impacts including collection and publication of statistics on aquaculture.

Scope of environmental assessment

The DENR-EMB Permitting Procedures (DENR-EMB, Philippines (2008a)) (Sec. 1.2, p.7) specify that EIA applies only to "Inland-based fishery project with water spread area from 300 m^2 to 10 ha". Implied on this provision is the clear coverage of EIA on lake-based aquaculture (*i.e.* pen and cages) but not pen/cages operations in coastal/municipal waters. The PD 1586 also addresses aquaculture indirectly. It identifies Environmentally Critical Areas where projects would be subject to environmental assessment. PD 1586 includes lakes and coastal waters as ECAs and in theory at least aquaculture development in these locations should be subject to environmental assessment.

Environmental review procedures for all projects as specified in EIA legislation are as follows:

1. Initial Environmental Examination (IEE). The IEE should contain a brief description of the project, expected impacts and measures to be undertaken to control, manage or minimize impacts of the project on the environment. The project proponent (farmer, investor) submits the IEE to DENR-EMB Regional Office. The IEE is normally conducted by a person or agency hired by the project proponent.
2. IEE Review. DENR-EMB processes and reviews the IEE as to the accuracy and sufficiency of information on the project and its impact and to ensure that the environmental management plan will sufficiently address adverse impacts. The DENR-EMB Regional Office may conduct on site investigations or public consultations during the course of the review. Affected LGUs, communities and other stakeholders are required to provide inputs during public consultations to ensure that their concerns are addressed.
3. Decision on Requirements for EIS (Environmental Impact Statement). The DENR Regional Executive Director determines whether the project IEE may further require an EIS, is acceptable as is, or is unacceptable. The project or its Environmental Compliance Certificate (ECC) may be denied if there may be potentially severe adverse impacts on the environment. EIS is required for projects that may cause significant impacts, involving large areas, altering landscape or relocating communities. An ECC may be issued without preparation of an EIS, if the DENR determines that one is not required. Aquaculture projects appear to be mainly subject to this lower level approach, provided that they are not situated at ECAs, *i.e.* (1) national parks, watershed reserves, wildlife preserves and sanctuaries; (2) areas set aside for aesthetic, potential tourist spots; (3) areas which constitute the habitat of endangered species or indigenous Philippine wildlife; (4) areas of unique historic, archaeological, geological or scientific interest; (5) areas which are traditionally occupied by cultural communities or tribes; (6) areas frequently visited and or hard-hit by natural calamities; (7) areas with critical slope; (8) areas classified as prime agricultural land; (9) recharge areas for aquifers; (10) waterbodies; (11) mangrove areas; and (12) coral reefs, or the development of fishpond will not utilize an area equal to or greater than 25 ha for inland-based, e.g. lakes, rivers, bays, or equal to or greater than 100 ha for projects in coastal areas.
4. Environmental Compliance Certificate (ECC). The DENR Regional Executive Director determines whether the ECC will be granted or denied. The EMB-DENR has the primary mandate of monitoring under the Philippine EIS system. However, the stakeholders have an equally significant role as well. Monitoring involves four main strategies, *i.e.* desk review of documents, field assessment and validation by EMB, monitoring by the Multipartite Monitoring Team (MMT) and by third party auditors (if necessary).

In general, ECC applications for aquaculture projects are based on the EIS or IEE report. In case the IEE report of the aquaculture project fails to address all environmental issues or concerns, the application will be upgraded to and require an EIS report.

Item 1.5.2 on Programmatic Environmental Performance Report and Management Plan (PEPRMP) is supposed to address an area-based EIA in aquaculture, but this provision does not specifically state how and when it is to be applied, and has never been implemented in coastal and lake-based aquaculture. No strategic environmental assessment has therefore been conducted for aquaculture plans or area based aquaculture developments, although provision exists in law for such an approach.

The scope of the BFAR issued Administrative Order 214 series of 2001 (FAO 214) that defines the Code of Practice for aquaculture (PHILMINAQ, 2006a) includes specific reference to the EIS procedures and relevant environmental assessment measures in several sections. The following are of particular note as they include reference to environmental assessment:

- Site Selection/Evaluation (Sec.2), which requires that the DA-BFAR, in consultation with the DENR, LGUs and Fisheries and Aquatic Resources Management Council (FARMC) shall identify and evaluate potential sites for aquaculture to ensure that ecological and social conditions are sustained and protected.
- Farm Design and Construction (Sec. 3), which states that Environmental Impact Statements (EISs) shall be required to be submitted to the DENR for review and evaluation before initiating any development activity or construction. The Section states further that fish cages, floating or stationary shall be installed and kept at least one meter between units, and at least 20 m between clusters to provide water exchange. Fish pens on the other hand shall be spaced 200 m apart and marine fish cages shall be operated only in definite zones established by the LGU concerned in consultation with the Municipality/Community FARMC.
- Carrying Capacity (Sec. 13), which refers to the establishment of criteria for the determination of the carrying capacity of lakes.

In addition, the Code of Practice for aquaculture includes reference to water usage, water discharge and sludge/effluent management, use of drugs, chemicals and potentially toxic pesticides and fertilizers, stock selection, stocking practices, introduction of exotic species and GMOs, feed, feed use and management and fish health management.

New farms versus operational farms

Environmental legislation requires environmental assessment for new and expanded operations of existing farms, covering the two categories (A or B) of aquaculture projects as detailed below. Expansions of existing projects are required to submit an environmental performance report and management plan, documentation showing actual cumulative environmental impacts of projects, with proposals for expansions. The environmental performance report and management plan should also describe the effectiveness of current environmental mitigation measures and plans for performance improvement. If the projects for expansion are co-located projects, the proponent is required to submit a programmatic environmental performance report and management plan (Tuyor *et al.*, 2007).

Category A Aquaculture Programme and Projects

Category A projects are those considered "Environmentally critical projects or projects with significant potential to cause negative environmental impacts"

Programmes/projects under this category must prepare either:

- *Programmatic Environmental Impact Statement* (PEIS), which is documentation of comprehensive studies on environmental baseline conditions of a number of projects ("co-located") in nearby areas. The programme statement should include an assessment of the carrying capacity of the area to absorb impacts from co-located projects. Recently, it has been used for Mariculture Zones/Parks.
- *Environmental Impact Statement* (EIS), on the other hand, refers to documents of studies on the environmental impacts of a project including the discussions

on direct and indirect consequences upon human welfare and ecological and environmental integrity. The following is the specific documentation required for new and existing projects, either co-located or single project.

A. New project: Co-located

At the minimum, the PEIS should contain the following:

- executive summary;
- summary matrix of scoping agreements as validated by EMB;
- project description;
- eco-profiling of air, land, water and relevant people aspects;
- environmental carrying capacity analysis;
- environmental risk assessments (if found necessary during scoping);
- environmental management plan;
- duties of environmental management unit;
- proposals for environmental monitoring and guarantee funds;
- accountability statements.

As regards *Environmental Impact Statement* (EIS) the following documentation is required for new and existing projects:

A. New project: Area plan

At the minimum, the EIS should contain the following:

- executive summary;
- summary matrix of scoping agreements as validated by EMB;
- project description;
- eco-profiling of air, land, water and relevant people aspects;
- environmental carrying capacity analysis;
- environmental risk assessments (if found necessary during scoping);
- environmental management plan;
- duties of environmental management unit;
- proposals for environmental monitoring and guarantee funds;
- accountability statements.

B. New project: Single project

At the minimum, the EIS should contain the following:

- EIS executive summary;
- scoping report identifying critical issues and concerns as validated by EMB;
- project description;
- baseline environmental conditions focusing on the sectors (and resources) most significantly affected by the proposed action;
- impact assessment focused on significant environmental impacts;
- environmental risk assessments (if determined by EMB as necessary found during scoping);
- environmental management plan;
- supporting documents, e.g. technical/socio-economic data, certificate of zoning, etc;
- proposals for environmental monitoring and guarantee funds;
- accountability statements;
- other clearances.

C. Existing projects for expansion: Co-located projects

The document required is a *Programmatic Environmental Performance Report and Management Plan (PEPRMP)*. PEPRMP refers to documentation of actual cumulative environmental impacts of co-located projects with proposals for expansions. The PEPRMP should also describe the effectiveness of current environmental mitigation measures and plans for performance improvement. The maximum processing time in deciding to grant or deny an ECC is 120 working days after the PEPRMP has been accepted by DENR-EMB.

At the minimum, the PEPRMP shall contain the following:

- project description of the co-located projects;
- documentation of the actual environmental performance based on current/past environmental management measures implemented;
- an EMP based on an environmental management system framework and standard set by EMB.

D. Existing projects for expansion: Single projects

The document required is an *Environmental Performance Report and Management Plan (EPRMP)*. EPRMP refers to documentation of the actual cumulative environmental impacts and effectiveness of current measures for single projects that are already operating. Similar to the EIS, the EPRMP should be submitted to the EMB Central Office and reviewed by an EIA Review Committee (EIARC) and endorsed by the EIA Division Chief to the approving authority (EMB Director). The maximum processing time in deciding to grant or deny an ECC is 90 working days after the EPRMP has been accepted by DENR-EMB.

At the minimum, the EPRMP shall contain the following:

- project description;
- baseline conditions for critical environmental parameters;
- documentation of the actual environmental performance based on current/past environmental management measures implemented;
- detailed comparative description of the proposed project expansion and/or process modification with corresponding material and energy balances in the case of process industries;
- an EMP based on an environmental management system framework and standard set by EMB.

Documentary requirements for Category B Aquaculture Projects

A. New projects

The document required is an *Initial Environmental Examination (IEE) Report*. IEE refers to the document required of proponents describing the environmental impact of, and mitigation and enhancement measures for, non-critical projects or undertakings located in an ECA. The IEE replaces the Project Description required under DAO 21, series of 1992. It should be submitted to the EMB Regional Office where the proposed project is to be located. The review shall be undertaken by the EIA Division and endorsed by the EIA Division Chief. The approving authority will be the DENR-EMB Regional Director. The maximum processing time in deciding to grant or deny an ECC is 60 working days after the IEE Report has been accepted by DENR-EMB.

At the minimum, the IEE Report shall contain the following:

- project description;
- a brief of the environmental setting and receiving environment, including the primary and secondary impact areas;
- a brief description of the project or undertaking and its process of operation;
- a brief description of the environmental impact of the project or undertaking, including its socio-economic impact;
- a matrix of mitigation and enhancement measures;
- a documentation of the consultative process undertaken, when appropriate;
- other clearances and documents that may be determined and agreed upon during scoping.
- accountability statements of the preparer and the proponent.

B. Existing projects for expansion: Co-located projects

The document required is a *Programmatic Environmental Performance Report and Management Plan (PEPRMP).* This should be submitted to the DENR-EMB RO where the projects are located, reviewed by an EIA Review Committee (EIARC) and endorsed by the EIA Division Chief. The approving authority will be the DENR-EMB Regional Director. The maximum processing time in deciding to grant or deny an ECC is 60 working days after the PEPRMP has been accepted by DENR-EMB RO concerned.

At the minimum, the PEPRMP shall contain the following:

- project description of the co-located projects;
- documentation of the actual environmental performance based on current/past environmental management measures implemented;
- an EMP based on an environmental management system framework and standard set by EMB.

The PEPRMP should present the actual cumulative environmental impacts of co-located projects with the proposed expansions. The PEPRMP should also describe the effectiveness of current environmental mitigation measures and plans for performance improvement.

C. Existing projects for expansion: Single projects

The document required is an *Environmental Performance Report and Management Plan (EPRMP).* Similar to the IEE Report, the EPRMP should be submitted to the DENR-EMB RO concerned, reviewed by the EIA Division and endorsed by the EIA Division Chief. The approving authority will be the DENR-EMB Regional Director. The maximum processing time in deciding to grant or deny an ECC is 30 working days after the EPRMP has been accepted by DENR-EMB RO concerned.

At the minimum, the EPRMP shall contain the following:

- project description;
- baseline conditions for critical environmental parameters;
- documentation of the actual environmental performance based on current/past environmental management measures implemented;
- detailed comparative description of the proposed project expansion and/or process modification with corresponding material and energy balances in the case of process industries;
- an EMP based on an environmental management system framework and standard set by EMB.

If new single or new co-located aquaculture projects are classified as Environmentally Critical Projects (ECP) and are located in Environmental Critical Areas (ECAs) or non-ECAs then the report type required is provided in Table 31 (DENR-EMB, Philippines (2008b).

TABLE 31

Reports required for aquaculture projects classified as Environmentally Critical Projects

Fish pond development projects			
Project type	**Project size parameter**	**Project size**	**Report type requirement**
Inland based e.g. lakes and rivers	Total water spread area to be utilised	≥25 hectares	EIS or ECC
Coastal waterbodies	Total water spread area to be utilised	≥100 hectares	EIS or ECC

If new single or new co-located aquaculture projects are classified as Non Environmentally Critical Projects in Environmental Critical Areas then the report type required is provided in Table 32.

TABLE 32
Reports required for aquaculture projects classified as Non-Environmentally Critical Projects

Fish pond development projects			
Project type	Project size parameter	Project size *	Report type requirement
Inland based *e.g.* lakes and rivers	Total water spread area to be utilised	≥ 1 hectares but < 25 hectares	Initial Environmental Examination (IEE) or IEE checklist or ECC
Coastal waterbodies	Total water spread area to be utilised	≥ 1 hectares but < 100 hectares	EIS or ECC

* All projects greater than 1 hectare require a Project Description Report (PDR)which is the basis for a request for the issuance of a Certificate of Non-Coverage (CNC).

Environmental monitoring

Environmental monitoring requirements should be identified during the preparation of the EIS and included within the Environmental Compliance Certificate. There are various modes of compliance monitoring depending on the classification of a project, *i.e.* compliance monitoring by EMB, self-monitoring by proponents, monitoring by third party auditors and monitoring by so-called multipartite monitoring teams (MMT).

a. Compliance monitoring by EMB. At the institutional level, a periodic monitoring of environmental impacts and compliance with ECC conditions as well as applicable laws, rules and regulations shall be the responsibility of the EMB regional office, with assistance from the central office if necessary. Compliance monitoring focuses on the status of delivery of commitments made in the Environmental Management Plan and meeting the terms and conditions as stated in the ECC.

b. Self-monitoring by establishments. It is the primary responsibility of the proponent to meet the conditions set in the ECC as well as those commitments made in the EMP. The proponents are expected to conduct regular self-monitoring and submit requisite reports to DENR-EMB.

c. Monitoring by third party auditors. Third party auditors are independent service providers accredited by the appropriated government agency and engaged by an establishment to conduct an environmental audit. Their services are usually required as an alternative to MMT for Classified A projects.

d. Monitoring by MMT. Multipartite monitoring teams are formed to encourage public participation, greater stakeholders vigilance and provide check and balance mechanisms during monitoring. They are composed of representatives from the DENR, the proponent, stakeholders, LGUs, locally accredited NGOs or Peoples' Organizations, the community, EMB regional office, relevant government agencies and other sectors that may be identified during the negotiation. MMTs are tasked to monitor project compliance to ECC and EMP and other requirements as may be specified by DENR.

e. Sectoral monitoring. In addition to the EIA provisions of the DENR, however, BFAR in collaboration with the LGUs and FARMCs has launched a programme on aquaculture environmental impact monitoring, particularly in mariculture parks and lake-based zonified areas for fish pen/fish cage operations basically following the provisions of FAO 214.

Voluntary instruments

There are no voluntary instruments as such in use by the aquaculture industry in the Philippines, but the Government of the Philippines through the BFAR has prepared a Code of Practice for Aquaculture (which is not voluntary, but mandatory and legal in nature) that includes specific reference to environmental assessment and monitoring, and that more generally is to improve the environmental management of aquaculture in the country (Table 33).

In addition, provisions under RA 8550 (which are not voluntary but obligatory and legal in nature) address "missing links" in DENR-EIS implementation as applied in aquaculture:

- Art.III, Sec. 45. No fish pens/cages or traps shall not be allowed in lakes two years after the approval of RA 8550;
- Sec.103 (b) stipulating penalties to individuals'/operators' failure to conduct yearly reports on fishpond, fish pens or cages;
- Sec 103 (e) Unlawful to construct and operate fish pens, cages without licence or permit;
- Sec. 47 Creation of Code of Practice for Aquaculture;
- Sections 51–55 specific provisions on cage farming;
- Sections 12 and 13 of the Fisheries Code states a reiteration of compliance to DENRs EIS and ECC.

TABLE 33
Code of Practice for Aquaculture based on FAO, 214

Item	Scope
Site selection/evaluation	Identification and evaluation of potential sites for aquaculture.
Farm design and construction	Requires environmental impact statements (EIS) and provides requirements for fish cage and fish pen installation. Installation guidelines for cages and fish pens
Water usage	Construction and operation of deep wells for freshwater supply and efficient water use
Water discharge and sludge/effluent management	Effluents, sediments management and disposal other wastes. Species requirements for water quality standards.
Use of drugs, chemicals and potentially toxic pesticides and fertilizers	Use of therapeutic agents and other chemicals used in fish farming without endangering food safety or threat to environment.
Stock selection, stocking practices (Sec.7)	Stocking of healthy fry and fingerlings.
Introduction of exotic and GMOs (Sec. 8)	Introduction of exotic and genetically modified organisms bio-safety standards.
Feed, feed use and management (Sec. 9)	Feed management, quality and techniques to minimize wastage.
Fish health management (Sec. 10)	Health management and quarantine procedures
Aquaculture data management (Sec. 11)	Database for environmental, social and land use impacts including collection and publication of statistics on aquaculture.
Carrying capacity (Sec. 13)	Criteria for the determination of the carrying capacity of lakes.

Source: after PHILMINAQ, 2006a

Practices

Environmental assessment

Although there is a well-established legal framework for environmental assessment of aquaculture, actual implementation in terms of project inclusion and scope of environmental assessment is still weak. Such problems are not specific for the aquaculture sector, but according to a recent World Bank/ADB report are common throughout the Philippines EIS system (Tuyor *et al.*, 2007). Recently, there has been work under the Philippines-EU funded project PHILMINAQ (PHILMINAQ, 2006a) on the development of carrying capacity models for milkfish (coastal) fish cage farming and tilapia cage culture in inland lakes in the Philippines, monitoring systems and government management guidance that show scope for wider application.

Environmental monitoring

Environmental monitoring requirements are highlighted in general above. The need to improve procedures and methods for the environmental monitoring of aquaculture is well recognized by BFAR and a number of simple points for improvement in monitoring environmental performance at the farmer/farm level have been identified as follows:

a. Environmental indicators

- legally required permits and documentation;
- environmental monitoring of waterbodies, e.g. pH, TAN, BOD, CFC and sediments, e.g. TSS, redox potential;
- data from workshops and consultations;
- eco-profiles of aquaculture farms and areas.

b. Environmental monitoring

- 6 months, 12 months and 18 months time period;
- parameters, procedures/methods, geographical location and frequency of monitoring are defined;
- cross check environmental monitoring data with the reference standards;
- regular evaluation of environmental performance, put into writing and disseminated, *i.e.* "record of the performance review".

Tuyor *et al.* (2007) also considers that the Philippine EIS system has a complex but poor system of follow-up and monitoring and virtually no evaluation study to determine and improve performance from projects. The feedback from monitoring to management is therefore a weak point requiring attention.

Personnel and costs

The costs of preparation of the environmental assessment and monitoring requirements are normally borne by project developers. For mariculture zones/parks, the costs of environmental assessment of the plans are being borne by government. Monitoring of these areas is also assisted by government funding.

Difficulties and constraints in practice

The major difficulties and constraints in practice to implementation of improved environmental assessment and monitoring of aquaculture in the Philippines have been summarized recently (PHILMINAQ, 2006b) as follows:

- Lack of clarity about the scope of authority. Local government staff are unclear about what their responsibilities really mean and how to go about fulfilling them.
- Inconsistencies and conflicts between national government agencies, and between national government agencies and local government units. Furthermore, non-implementation of the Joint DA-DENR Memorandum Order No. 01 of 2001, designed to assist cooperation between the responsible agencies for fisheries and environment, has hampered effective environmental management of the aquaculture sector.
- Lack of enforcement remains a continuing concern. There are sufficient laws and regulations covering aquaculture, but in many cases, enforcement is lacking or extremely weak. The reasons for this include a lack of knowledge on aquaculture management by enforcement staff; lack of funding for boats and petrol to check licences; lack of operational budgets and lack of trained coastal law enforcement units.

More generally, Tuyor *et al.* (2007) emphasize the following difficulties in implementation of the EIS system, most of which are relevant for aquaculture:

- it is administered by a central government agency; the role of local governments is very limited;
- the manner of its implementation is highly regulatory and control-oriented, emphasizing compliance to rigid bureaucratic procedures;

- more attention is paid to the procedural rather than on the technical aspects, resulting in generally poor quality environmental assessment characterized by voluminous reports and lack of focus and depth of analysis on critical issues and impacts;
- it has many overlaps with other laws as the EIS system tends to incorporate requirements of laws that are already handled by other agencies. These overlaps are becoming worse as new laws passed after Presidential Decree 1586 tend to include provisions that modify the EIS system;
- there is a complex but poor system of follow-up and monitoring and virtually no evaluation study.

These concerns, rather than purely technical matters and access to methodologies, are the principle difficulties with respect to implementation of effective environmental assessment and environmental monitoring for aquaculture in the Philippines.

Effectiveness

Technical appropriateness

Environmental assessment for aquaculture is in practice limited to a few larger projects, but has limited effectiveness for large numbers of small-scale farms. The increasing application to mariculture zones could improve its effectiveness, but techniques for assessment and monitoring need to be improved and implementable to improve the quality of the environmental assessment and decision-making.

The EIS system's contribution as a planning tool has been limited. The planning contribution could be achieved by implementation of the Programmatic Environmental Assessment introduced in 1995. The application to the aquaculture sector has been limited to date, and the techniques for environmental assessment of plans poorly developed in the country.

Use of data for improved performance of aquaculture

Data collected through the environmental assessment process and the subsequent monitoring is not well used for improving the performance of aquaculture. New guidance documents prepared by the PHILMINAQ project to assist local government units in better environmental management emphasize the importance of simple environmental data collection and use of the data for management adjustments/improvements. Implementation of these guidelines, a substantial challenge, will be necessary to see achievements "on the ground".

Impact of EIA and monitoring on environmental protection

Environmental assessment can be a good tool for environmental protection. However, it can also be used more narrowly to support economic interests. Government guidelines clearly state the pursuance of economic development as a priority. This may indicate that the government somehow recognizes civil society and environmental concerns as a weakening factor and the government is getting bolder in pushing for more economic objectives. The recent World Bank/ADB review of environmental assessment in the Philippines suggested that the use of EIS had not been effective in improving environmental management (Tuyor *et al.*, 2007) and interestingly suggested that slow approval procedures and "swamping" of the system with environmental requirements for small and medium enterprises may even have contributed to slow economic growth.

In the aquaculture sector, the use of environmental assessment has probably not contributed to overall environmental protection for habitats and aquatic resources. The recent emphasis on more regional planning, mariculture zones and application of sectoral management tools such as codes of practice and certification are likely to prove more effective and as such should continue to be pursued, with regular performance review, and incorporation of necessary improvements from such reviews.

Feedback and review

Existing environmental assessment procedures do provide for periodic review of the EIS to assess whether the mitigating measures are effective or unnecessary and whether change in EMP suffices. In practice, these feedback and review mechanisms are commonly not used. Since the promulgation of the Local Government Code, there has been an increase in the local government's ability to engage and influence the EIA process. Such influence remains controversial, if certain decisions are to be made in the light of political interests. The Local Government Units sometimes do not have enough technical competence to make sound judgements, and more capacity building is required at this level.

Perceptions of stakeholders

There is a perception from non-government organizations that the environmental assessment system leaves the community out of the process. The flow of communication between stakeholders, especially local communities must be improved and the use of simple language and communication in the EIS process is required.

Improvements

To date, there has been limited application of environmental assessment to most aquaculture projects in the Philippines, although there is a legal basis for applying environmental assessment widely within the aquaculture sector, both as part of a formal EIA process managed through the DENR system or sectoral management agencies.

A major trend in the country is to develop an effective system of local management in line with the government decentralisation policy, and a major challenge for improvement is to incorporate environmental management of aquaculture into that process.

The following suggestions are made for improvement:

- The focus of improved environmental management of aquaculture needs to be directed towards the local government units and increased responsibility given to farmers and farmer associations. This will require substantial capacity building, as well as addressing the various other constraints of decentralised EIA as highlighted in Tuyor *et al.* (2007).
- EIA legislation does not currently state directly that marine-based aquaculture activities are included. The DENR-EMB Permitting Procedures (Sec. 1.2, p.7) specify that EIA applies only to "Inland-based fishery projects with water spread areas from 300 sqm. to 10 ha". Implied on this provision is the clear coverage of EIA on lake-based aquaculture (*i.e.* pens and cages) but not pen/cages operations in coastal/municipal waters. There is a need therefore to review the present scope of environmental assessment and ensure proper coverage of the environmental risks, both in terms of farming systems and ecosystems where farms might be located. A key objective should be to identify the key risks, to key ecosystem and social values, and strategies to address these risks, rather than adopting a further simplistic "area-based" (*i.e.* farms over 10 ha) type approach.
- The quality of environmental assessments should be improved and supported through guidelines, capacity building, competency development and better collaboration between producers, producer organizations, EIA and monitoring experts, regulators, NGOs and certifiers, in the process of environmental assessment and monitoring.
- Environmental assessment reports and monitoring information should be made available via the internet and other publications. Mechanisms to share learning and outcomes of experiences on the ground should also be explored.
- The prospects for environmental assessment need to be reviewed in the light of national development interests and environmental objectives and focus on key

environmental risks and outcomes. The use of strategic environmental assessment of plans and zones has potential to enable more strategic application of resources for environmental assessment. Similarly, the effectiveness of the use of sectoral approaches (e.g. codes of practice) versus more formal EIA legal procedures should be reviewed in relation to costs, practicality and environmental and economic outcomes.

- In 2008, a Joint Administrative Order No. 1, series of 2008 (JAO) between the DENR, Department of Interior and Local Government (DILG) and the Department of Agriculture (DA) has been drafted for signatures of the Department Secretaries concerned. This JAO is entitled: Defining/Identifying the areas of cooperation and collaboration among the Department of Agriculture (DA), Department of Environment and Natural Resources (DENR) and the Department of Interior and Local Government (DILG) in the planning, management and control of aquaculture development to mitigate impacts on the environment. Implementation of this JAO should be a priority.

THAILAND[13]

Requirements

Environmental impact assessment

The Enhancement and Preservation of Natural Environmental Quality Act (1992) specifies that large scale projects that might cause significant environmental impacts should submit an EIA report to the Office of Natural Resources and Environmental Policy and Planning (previously Office of Environmental Policy and Planning) of the Ministry of Natural Resources and Environment. The first mandatory requirement for EIA was issued in 1981, under Section 46 of the Enhancement and Conservation of National Environmental Quality Act 1992. Guidance on EIA procedure is provided by the Environmental Impact Bureau, Office of Environmental Policy and Planning (now the Office of Natural Resources and Environmental Policy and Planning or ONEP). EIA reports must be prepared only by registered consultants, research institutes, or universities registered with ONEP (Thailand, 2006).

Examples of listed projects requiring EIA identified by the Ministry of Natural Resources and Environment for the approval of the National Environmental Board (NEB) are: dam or reservoir construction, irrigation projects, commercial airports, hotels or resorts, mass transit systems and expressways and certain industrial projects (*i.e.* petrochemical, iron or steel, cement *etc*).

Aquaculture is not mentioned under EIA legislation in Thailand, although the principle and analysis framework of EIA may be applied to aquaculture. A classical example is the prohibition of shrimp ponds in freshwater areas in 1998. Environmental studies were conducted showing potential impacts on soil salinization as well as social conflicts in resource use, leading to a ban on construction of shrimp ponds growing black tiger shrimp in freshwater zones using the authority of the Prime Minister via the Provincial Governors in affected areas, under Section 9 of the Enhancement and Conservation of National Environmental Quality Act 1992.

Although EIA is not legally required for aquaculture, the environmental assessment, monitoring and management of aquaculture activities in Thailand are also conducted under the responsibility of the Ministry of Agriculture and Cooperatives as well as other central, provincial and local governments. Various legal instruments cover the environmental aspects of planning and operational management of aquaculture activities in Thailand, covering a wide range of relevant environmental issues.

[13] Contribution by Rattawan Tam Munkung

Aquaculture farm siting is relevant to the Land Development Act (1983), Land Code (2001), and the Enhancement and Preservation of Natural Environmental Quality Act (1992) concerning the prohibited zones for aquaculture in the environmentally protected areas and pollution control areas. For instance, ponds are not allowed to be constructed in designated mangrove areas. Also, farmers have to submit the document for proving their right on the land through the Department of Forestry or Ministry of Natural Resources and Environment for farm registration; and the layout of new farms should be approved by local authorities. In the case of farm renting, the contract of farm renting must be submitted as a supporting document for farm registration. The suitability of sites in terms of water and soil quality, water supply and access to inputs is another limiting factor in controlling the expansion. No clear legislation is in place for designation of marine areas for cage culture or other marine aquaculture operations, although this is an area of increasing interest to government and investors. Operational aspects for inland and coastal farms are also well covered under various legal arrangements, much of which is administered and implemented by the Department of Fisheries (DoF) under the Ministry of Agriculture and Cooperatives. Considerable emphasis is placed on coastal aquaculture, and particularly shrimp farming, due to its high value and importance as an export earner to the country. Table 34 summarizes some of the formal environment-related management measures.

TABLE 34
Environment-related management measures for aquaculture in Thailand

Environmental issues/aspects	Management activities
National policy and plans for aquaculture to incorporate environmental aspects	Development of national policy and plan of environmental management in aquaculture
Environmental evaluation of farming locations	Farm location evaluation and registration
Quality control of main inputs (broodstock, post-larvae, feed, chemicals and therapeutic agents)	Provision of the list of registered non-pathogen broodstock sources to prevent the introduction of new disease
	Quality control of post-larvae by detecting pathogens
	Monitoring of feed quality in terms of chemical properties especially the minimum nutritional requirements
	Prohibition of some chemicals and antibiotics usage that may lead to human health impacts
	Provision of instructions on the usage of therapeutic agents to prevent the contamination in final products
Effluent impacts from coastal aquaculture and monitoring	Development of effluent standard of wastewater from coastal aquaculture and monitoring the coastal water quality
Certification systems of food safety management and environmental management programme of hatchery, farm and harvesting activities	Development and monitoring of the certification systems of environmental management programme of hatchery, farm and harvesting activities, including technical guidance on how to implement the certification criteria so as to minimize the environmental impacts associated with production activities, including the issues of social responsibility.

Administration and responsibilities

At the national level, the NEB has the authority to pursue policy and plan for enhancement and conservation of national environmental quality and to approve environmental quality management plans at the provincial level. NEB plays an important role in overall environmental management in all activities that could lead to significant impacts to the public, including aquaculture. However, environmental assessment, monitoring and management practices for aquaculture are under the sectoral responsibility of the Department of Fisheries (DoF) of the Ministry of Agriculture and Cooperatives. There are also other organizations (institutions) involved in some aspects of the operational control of aquaculture, for instance, Department of Livestock and Pollution Control Department.

At the local level, strategic plans for development of aquaculture, and other uses of natural resources, are prepared at provincial or district (known as Tambon) level according to the national policy and plans from the national government. Provincial/district government and provincial fishery offices are the main organizations responsible for aquaculture operational control, environmental assessment, monitoring and management within their territory. There is increasing emphasis on decentralisation of environmental management responsibilities to the provincial and district levels in Thailand. The list of institutions responsible for environmental management of aquaculture is given in Table 35.

TABLE 35
List of institutions responsible for environmental management of aquaculture

Institution (s)		Responsibilities
Ministry	**Department**	
Ministry of Natural Resources and Environment	Office of Natural Resources and Environmental Policy and Planning	Overall environmental policy and planning for the national level in all activities
	Department of Forestry	Identification of suitable land areas for aquaculture activities
	Department of Land Development	
	Pollution Control Department	Pollution control by setting effluent standards and monitoring the water quality in rivers
Ministry of Agriculture and Cooperatives	Department of Fisheries (DoF)	National policy on production and operational control, including environmental assessment, monitoring and management for aquaculture (as well as fisheries)
	Department of Livestock	Control of feed quality and veterinary drug usage
Ministry of Public Health	Department of Medical Science	Testing of contamination in flesh meats
Ministry of Industry	Department of Industrial Work	Control of hazardous substances production, import and export and uses

Within DOF, there are several units responsible for aquaculture, including:

- Standard Control of Aquatic Product Division to examine and issue health certificates for exporting;
- Development of Aquatic Product Industry Division to develop post-harvest technology;
- Fisheries and Aquaculture Management Division to establish laws and legislations for controlling and managing fisheries and aquaculture activities;
- Research and Development of Coastal Fisheries Institute to develop aquaculture technology and examine the aquaculture operations especially in coastal zones to meet food safety and environmental standards;
- Research and Development of Freshwater Fisheries Institute to develop aquaculture technology and examine aquaculture operations especially in freshwater areas to meet the food safety and environmental standards;
- Knowledge Transfer of Research and Development Institute to transfer knowledge to farmers.

Scope of environmental assessment

The scope of EIA reports as defined in Thailand's EIA guidelines should include the following:

1. purpose of project as well as its benefits, including the permit license, land use right or any other documents;
2. project description in terms of type, size, production capacity; project justification, project size and access to the site; project implementation timetable; reasons for site selection; detailed information of project activities (e.g. raw material, energy,

infrastructure requirement, number of workers, detailed actions of project construction and operation); pollution and wastes generated from the project construction and operation; and detailed information on waste management systems;
3. environmental conditions to reflect the present state in four main elements: abiotic resources (*i.e.* minerals, soil, etc.), biotic resources (*i.e.* animals, plants, etc.), human use value (*i.e.* land use) and quality of life value (*i.e.* socio-economic, health, historical and recreation values).
4. environmental impacts from the project including direct, indirect, short- and long-term impacts must be assessed and addressed according to the severity of impacts, which should cover irreversible and irretrievable loss of environmental values, based on the predicted future impacts, with technical justification;
5. measures to mitigate environmental impacts or compensate for any damage incurred;
6. comparison of advantages and disadvantages of alternative sites as well as no project development, to provide understanding of site suitability and options;
7. monitoring plan to ensure the effectiveness of preventive measures, and to include description of monitoring site, parameters, frequency, environmental standards, methodologies and frequency of monitoring reporting.

Although EIA is not legally required for aquaculture, environmental assessment is conducted within the context of several procedures associated with the planning of aquaculture operations. In general, these procedures are applied mainly to shrimp farming, and not to small-scale freshwater aquaculture in inland areas. Shrimp farming, as a major export aquaculture activity in Thailand, has received the most significant attention, including inland shrimp aquaculture.

The overall environment management policy and plan in aquaculture is set at the national level. Based on the policy directives of National Economic and Social Development Plans, aquaculture production and management plans are set accordingly. Management strategies are then addressed in the policy of the Department of Fisheries as well as other related organizations. For instance, the target of aquaculture production in the 9th National Economic and Social Development Plan (2002–2006) was an increase of 5 percent annually. Issues concerning cost-effectiveness, environment-friendly aquaculture production systems, post-harvest technology development and hygiene management, and enhanced competitiveness of aquaculture products in international markets are highlighted.

Environmental evaluation of farm location is conducted for farm registration. The provincial fishery offices are involved in the farm registration, and are required to coordinate with the local government Tambon Administration Organization (TAO); the latter is involved in the approval of layout of the new farm, which is not to be operated in prohibited areas such as mangroves or any other sensitive areas that might lead to social conflicts. Moreover, it is the authority of TAO to monitor and control the aquaculture activities to avoid causing negative environmental impacts.

Environmental monitoring

Environmental monitoring is conducted within the scope of several management activities associated with aquaculture in Thailand.

Environmental monitoring of aquaculture activities in a specific area or community are the responsibility of the provincial fishery offices. These tend to be practical and linked to farm management and effluent monitoring, for instance, providing services on disease control, pond and effluent management (*i.e.* checking the water quality during the culture period or testing discharge wastewater quality during or after harvest).

Considerable environmental monitoring efforts are conducted within the framework of management initiatives for shrimp farming, being implemented by DoF. These efforts cover:

- Monitoring associated with farm certification and use of voluntary instruments as noted below.
- DoF has developed the online traceability system called ‘ThaiTraceShrimp” (available online at www.thaitraceshrimp.com) to provide supply chain data. Fisheries Movement Documents (MD) are also used to regulate the “movement” of aquatic animals, which requires hatcheries and farms to provide data on sources of broodstock, post-larvae and other inputs so that any contamination of shrimp products can be traced back along the production chain.
- Monitoring of broodstock and post-larvae quality control. The control of disease in broodstock is implemented strictly, particularly for imported shrimp. According to the DoF regulation concerning the import of white shrimp (*Peneaus vannamei*), only specific pathogen free broodstock may be imported, from registered bio-secure hatcheries. There must be no movement within 15 days, and after that movement is allowed with the attachment of a movement document. The list of registered broodstock sources is provided by DoF.
- Monitoring of feed quality control. DoF checks the quality of aquaculture feeds (*i.e.* nutrient levels of feeds available in the market) regularly, under the Animal Feed Control Act (1992) administered by the Department of Livestock.
- Residues in aquatic animals are monitored under the Food Act (1979) and Drug Act (1967). A residue monitoring plan is also a requirement of trade with the European Union, and is submitted annually for EU review (Thailand, 2007a).
- Effluent standard of wastewater from coastal aquaculture. Water pollution from coastal aquaculture is subject to control through effluent standards for coastal aquaculture set by the Marine Environmental Division of the Pollution Control Department. The range or maximum permitted values of effluent water quality parameters are provided in Table 38.

Voluntary instruments

In recent years, there has been increasing use of voluntary measures to encourage and support improved environmental management of aquaculture in Thailand (Pongthanapanich and Roth, 2006). The two principle initiatives (DoF Thailand, 2002a; 2002b) are:

- Good aquaculture practice “GAP” programme (DoF Thailand, 2008b), which focuses on assuring hygiene and food safety of aquaculture products. GAP was developed initially for shrimp farming, but the programme has recently expanded to include marine fish and tilapia.
- Code of Conduct for Responsible Shrimp Farming, which covers product safety plus environmental and social responsibilities.

These certification systems of food safety management (Good Aquaculture Practices, GAP) and environmental management (Code of Conduct for Responsible Shrimp Aquaculture, CoC) were developed by DoF, in consultation with a range of industry stakeholders. They include standards for certification, and are supported by technical guidelines for farmers and certifiers on how to implement certification for hatchery, farm and harvesting activities. GAP is focused on assuring hygiene and food safety of aquaculture products (Table 36) whilst CoC addresses environmental protection, regulatory compliance, quality and safety, efficiency, social responsibility, education and training (Table 37).

DOF has recently reviewed the implementation of these certification programmes and an updated version of GAP and CoC will add some new aspects; for example the environmental management aspects of CoC will also include the reforestation and energy conservation, and animal welfare is also being considered. The new version will also put more emphasis on data recording systems (DoF Thailand, 2008a).

TABLE 36
Major elements of the Good Aquaculture Practice guideline (DoF Thailand, 2008b)

Item	Scope
1. Site Selection	Near water supply source, no pollution source and legal land with the farm being registered.
2. Pond management	General pond management includes hatchery layout, pond preparation, water preparation, health checking of broodstock, water quality monitoring
3. Feed, feeding and post-larvae production	Use of registered and good quality feeds, effective feeding, production of live feeds according to requirement of larvae in each stage, use of registered chemicals and drugs for shrimp health management or water quality control.
4. Post-larvae health management and disease treatment	Monitoring of shrimp health and disease infection, use of registered veterinary drugs according to the instructions provided
5. Sanitary condition of hatchery facilities	Sanitary control of hatchery areas and facilities, sanitary toilet with no contamination to hatchery production systems, good solid waste management, the total and faecal coliforms in water used meets the requirement
6. Harvesting and transport	Planning of harvesting, harvesting method with shrimp quality control, movement documents for transporting
7. Data recording	Data recording and updating of hatchery production activities

TABLE 37
Major elements of the Code of Conduct for Responsible Shrimp Farming

Item	Scope
1. Site selection	Site selection such as outside mangrove zones and legal land with the farm being registered.
2. Pond management	General pond management such as farm layout, pond preparation, water and pond soil quality check, water management and other daily farm operations.
3. Pond stocking	Stocking such as density, suitable seed size and quality.
4. Feed and feeding management	Feed management such as feed storage and feed management for efficient food conversion ratio (FCR)
5. Shrimp health management	Shrimp health management such as daily health check, disease control and prevention.
6. Drugs and chemicals	Therapeutic agents and chemicals, in which only specified therapeutants are used and only when absolutely necessary
7. Effluents	Wastewater treatment before effluent discharge, including sludge treatment and farm sanitation methods.
8. Harvesting	Harvesting and distribution such as harvesting plan and methods, quality and antibiotic residue checking.
9. Social responsibility	Social responsibility concern over labor welfare and participation with local community.
10. Farmer associations	Farmers association and training.
11. Record keeping	Farm record keeping to facilitate evaluation (Use of farm manual to record farm production systems and management activities).

Both the above programmes target and provide opportunities for product certification, for export and domestic markets. Some private certification schemes are also emerging in Thailand – national and international – which also include reference to environmental assessment and management. Examples of other certification schemes applied in Thailand are Organic (Naturland) and ACC (Aquaculture Certification Council) required by buyers/customers in EU and the United States of America respectively.

These programmes involve farm monitoring, training and auditing for certification, which at present is mainly conducted by DoF. The evaluation guidelines assign different weights to each standard, ranging from 5–15 percent. The final score is given based on the average of the summation of score in individual standards. However, the new version of GAP/CoC will assign different levels (critical, major and minor) to each criterion (DoF Thailand, 2008b). For the certification procedure, the development of certified auditors, certifying body and accreditation body based on the ISO/IEC Guide 65 is being considered.

The planning for aquaculture sites is also included in CoC and GAP documents. The importance of suitable location of shrimp farms is emphasized as a key factor for food safety, and to help minimize environmental and social impacts. A guideline provides further details; for example the guideline for site selection notes that a good farm must be located in non-acidic soil, close to a good quality seawater source and far from other pollution sources. The CoC also broadly covers the major environmental issues associated with operational management as shown in Table 37. A sludge storage pond is also required in CoC provisions to prevent one of the major impacts of shrimp farming on water quality in coastal ecosystems.

Practices

Environmental assessment

There are no environmental assessment methods identified for aquaculture as part of a formal EIA process required by law. Nevertheless, various environmental assessment approaches and methods are in use in Thailand for assessing impacts of aquaculture on the environment:

- Environmental assessment for environmental policy. Aquaculture environmental management policy is evaluated and assessed for improvement through quality assurance systems used for evaluating the performance of governmental organizations.
- Land use for aquaculture activities. The land areas used for aquaculture activities are assessed by using aerial photos and geographical information systems (GIS). Moreover, potential impacts on soil salinization, particularly for inland shrimp farming, as well as social conflicts in land use have been assessed through various scientific research projects conducted by government research and development institutes and universities.
- Assessment of broodstock, post-larvae and feed quality. Broodstock and post-larvae quality is assessed using quality criteria based on physical characteristics and pathogen detection techniques. For feed quality control, chemical properties of feeds in terms of percent protein, percent fat, percent phosphorus, percent fibre, percent ash and moisture content are checked randomly from the feeds available in the market to determine if minimum nutritional requirements are reached. Feed plants in Thailand are also subject to various certification requirements, including recently certification that feeds do not contain GMO ingredients. Veterinary drugs and other residues are also checked occasionally in feeds as part of the government residue control plan.
- Assessment of residues of chemicals and therapeutic agents. There is an extensive programme of residue testing through sampling of aquaculture products. Moreover, it is legally compulsory to use only chemicals and therapeutic agents that are approved for aquaculture activities.
- Assessment of water quality. Coastal water quality is assessed with a Marine Water Quality Index (MWQI) covering the integration of dissolved oxygen, pH, suspended solid, coliforms, total nitrogen, total phosphorus, ammonia-N, nitrate-N, pesticides and toxic elements monitored in 240 water quality monitoring stations throughout the country. MWQI is ranged from 0 to 100 by applying weighting factors to different parameters (sub-index) measured and integrated into the final index score: 0–25 very bad, >25–50 bad, >50–80 fairly good, >80–90 good and >90–100 very good.
- Assessment for GAP and CoC certification. The applicants (hatchery operators, farmers or harvesting teams) must submit the application form together with supporting documents such as right on land, hatchery/farm layout and production systems, a shrimp-club or association membership document, and others to the provincial fishery office. The auditing form consists of a checklist of evaluation criteria that are used by the auditor to evaluate compliance to certification standards. In the case of non-compliance, guidelines on how to improve will be

given to the farm, and corrective actions must be conducted within a period of time indicated in corrective action plans. Another auditing will be conducted again before the certificate can be issued.
- Assessment for food safety. Sampling of product for export, especially to European countries, is conducted and samples are tested for various residue contaminants by DoF. A certificate is issued by the DoF Standard Control of Aquatic Product Division, to the processing factories as evidence of food safety for quality control purposes at the port of entry in destination countries.

Environmental monitoring

Environmental monitoring is conducted within the scope of several management activities associated with aquaculture in Thailand, as noted earlier. Aquaculture operational controls in various environmental management schemes are monitored mainly by DoF as well as other institutions (detailed in Table 35). On-farm monitoring is also conducted, particularly on larger farms. The practices of environmental monitoring in aquaculture include the following:

- Monitoring of environmental management in aquaculture. Environmental monitoring of aquaculture activities in a specific area or community is the responsibility of provincial fishery offices. These offices conduct regular monitoring in aquaculture areas, and on farms, with an emphasis on water quality and disease testing.
- Monitoring of farming locations for farm registration. The Tambon Administration Organization is responsible for checking if the farm is located in mangrove or any sensitive areas that might lead to social conflicts. Aquaculture activities will also be monitored so as not to cause negative environmental impacts on the local environment and community. Most such monitoring is conducted through site inspections.
- Monitoring of broodstock and post-larvae quality control. Quality control and disease status of broodstock and post-larvae are checked by using the PCR (polymerase chain reaction) techniques for most serious pathogens. There are many laboratories, both from DoF and private companies, providing such a service. Most farmers are aware of the importance of quality shrimp post-larvae, and will request a certificate of disease status for any shrimp post-larvae purchased.
- Monitoring of feed quality control. The control of aquaculture inputs especially feed is described in the Animal Feed Control Act (1992) administered by the Department of Livestock. The act regulates the content and quality of feed used for aquaculture. Within DoF, feed sampling from markets is conducted once every four months by provincial fishery offices and the samples are sent to the DoF Aquatic Animal Feed Research Institute to check nutritional values. The Aquatic Animal Feed Research Institute is also responsible for the study, analysis and research of aquatic animal feed.
- Monitoring of residues in aquatic animals. The Food Act (1979) gives authority to fisheries officers to collect a sample of aquatic animals for testing from any place but not from a processing plant. The samples are tested by the Department of Medical Science, Ministry of Public Health and by the DoF laboratories. Private facilities are also available in Thailand.
- Monitoring of chemicals and hazardous substances for aquaculture activities. The Drug Act (1967) provides the authority for collection and testing of samples of inputs and aquatic products. Fisheries officers who have the authority for sample collection are: the Director, the Deputy Director, the Provincial Fisheries station head, the fisheries officer of Department of Aquatic Feeds and Department of Aquatic Diseases of the Research and Development Institute of Freshwater and the Research and Development Institute of Coastal Aquaculture and the head

of Career Promoting and Developing Department of the Provincial Fisheries Offices.

- Effluent standards for coastal aquaculture developed by the Pollution Control Department (PCD) aims to control the water pollution problems (Pollution Control Department, Thailand, 2007) (Table 38). The water quality is checked twice a year during rainy and dry seasons, sampling and analysing is done by the Seawater Quality Unit of the PCD. The water sampling method for effluent standard examination control must be grab sampling from a discharge point in the coastal aquaculture area. The analytical method must be based on the Standard Methods for the Examination of Water and Wastewater (APHA, AWWA and WEF), Practical Handbook of Seawater Analysis (Strickland and Parsons), Methods of Seawater Analysis (Koroleff), Determination of Ammonia in Estuary (Sasaki and Sawada) Methods of Seawater Analysis (Grasshoff) and /or Manual for Water and Wastewater Examination of Environmental Engineering Association of Thailand and WEF.
- Monitoring procedures have also been developed under the Good Aquaculture Practices and Code of Conduct schemes operating for shrimp farming. These include:
  - self monitoring (recording keeping) by farmers;
  - monitoring by government authorities (mainly DoF provincial offices that are equipped with environmental monitoring facilities).
- Certification standards for CoC and GAP are aimed to ensure that the production of shrimp and other aquaculture products is practiced with food safety and environmental considerations. Especially in CoC, the main environmental issues associated with production processing are included: site selection, broodstock capture, feed quality and feeding management, water and wastewater, chemical and therapeutic agent uses and sludge disposal. However, the standards are rather subjective without complete guidance on compliance. Moreover, there are some environmental issues of concern that are not yet captured by the certification system, for instance feed ingredients, their sources and digestibility levels. The legal requirement on effluent standards of coastal aquaculture is also not stated clearly in the CoC, as well as the monitoring system. DoF has recently completed a review of the CoC and GAP programmes, and are planning various improvements.
- Monitoring associated with traceability. DoF has also launched a traceability scheme to provide market incentives for shrimp farmers to adopt the CoC and GAP. Fisheries Movement Documents are used to track the "movement" of aquatic animals so that aquaculture products and contamination can be traced back along the production chain.

TABLE 38
Effluent standards for coastal aquaculture

Parameter	Unit	Range or maximum permitted values	Method for examination
1. pH	-	6.5–9.0	pH meter
2. BOD (biochemical oxygen demand)	mg/l	20	azide modification by synthetic seawater
3. SS (suspended solids)	mg/l	70	glass fibre filter disc
4. NH_3-N (ammonia nitrogen)	mgN/l	1.1	modified idophenol blue
5. Total phosphorus	mgP/l	0.4	ascorbic acid
6. H_2S (hydrogen sulfide)	mg/l	0.01	methylene blue
7. Total nitrogen	mgN/l	4.0	(1) persulfate digestion (2) nitrogen analyser

Source: Thailand, 2004; 2005

Personnel and costs
The costs of much environmental monitoring are borne by government. In a few cases, with larger shrimp farms, the company will also invest in environmental monitoring, as part of ongoing management or certification requirements. Testing of shrimp post-larvae for disease is often paid for by the farmer and there are a number of private laboratories in Thailand offering various environmental and analytical services for the aquaculture industry.

Difficulties and constraints in practice
Various organizations are responsible for environmental management of aquaculture activities. The operational control of aquaculture production activities together with the monitoring of environmental management overlaps between responsible origanizations, thus the implementation is not as effective as it could be.

Although water quality in natural waters is monitored, this monitoring has limited connection to a preventive management approach. For instance, modelling of nutrient enrichment and/or eutrophication from aquaculture (both positive and negative impacts) is not yet included in the framework of environmental monitoring for coastal aquaculture, which tends to be somewhat "static" in nature. The challenge in future is to link investments in environmental monitoring more closely to management objectives for aquatic ecosystems and waterbodies.

With respect to certification, a GAP checklist is provided for auditors with suggestion of improvement if standards are not met. For auditing, the final scores of GAP are based on the average score of compliance levels (very good, good, fair and bad). However, the qualifications of auditors are not clearly defined. Average scores applied in GAP may also give a misleading result. In a similar way, CoC gives different levels of scores (4, 3, 2, 1 and 0) for compliance in different criteria categories together with the application of grouping and weighting of main clauses afterwards. Highest weighting factors are given to the criteria numbers 2, 5, 6 and 7 (15 percent) followed by the criteria numbers 1, 3, 8 and 10 (10 percent) and the criteria numbers 9 and 11 (5 percent) (referred to the criteria or standards in Table 38). The final scores of CoC linked to the period of being certified (ranging from six months to two years) may give an incorrect impression of the farm's performance. Monitoring systems also need to be improved, not only when the certificate needs to be extended. Farmers are responsible for compliance at all times and probably more monitoring is needed between issuance and renewal of certification.

Effectiveness
Technical appropriateness
<u>*Farm siting assessments and monitoring*</u>
Aquaculture is not allowed in mangrove forests and the type of land use for aquaculture is identified based on the suitability of site for farming (in terms of water supply, soil property, infrastructure and the distance from other sources of pollution) together with the land use document or licence for rented farms. However, those factors are mainly focused on new farms and a number of constraints exist:

- There are still small numbers of non-registered farms; however, a significant effort over the past two years has reduced substantially the number of unregistered shrimp farms, with now over 95 percent of shrimp farms now registered. Small-scale freshwater farms are mainly un-registered.
- It still remains difficult to control the number of farms in a particular area and to maintain farming levels within carrying capacity. Interactions of aquaculture with other activities in the same area are not yet considered for site selection or ongoing management. Addressing such issues has so far proved difficult within current management practices.

Operational control

The operational control activities are mainly focused on shrimp aquaculture, as it is the main commodity cultured, and subject to various export controls, so it is discussed here in detail. The measures for operational control are generally regarded as more effective and technically appropriate. Some areas where further technical improvements and management measures may be warranted are:

- Broodstock and post-larvae quality is controlled by PCR and other pathogen detection methods. The biodiversity impacts from introduction of *Penaeus vannamei* which is an exotic species have not been completely assessed and monitored. The presence of *P. vannamei* in rivers has been reported, though there is no evidence as yet for any negative impacts on aquatic ecosystems.
- Improvements on efficiency in use of post-larvae and broodstock. For indigenous *P.monodon*, further research and development of a domesticated broodstock would reduce pressures on wild resources and marine ecosystems.
- Feed quality control involves regular monitoring of nutritional values and residues. Ingredients and their sources and pollution impacts of feeds are not well researched. Of particular concern is the use of fishmeal in feed production, and the need to reduce future use of fish meal in aquatic animal diets.
- Monitoring of water quality in rivers and coastal areas is conducted on a regular basis but there is less attention to wastewater discharge and individual pond monitoring. A major constraint is related to the financial and human resources required for sampling numerous ponds. There is a need for cost-effective and better integrated environmental monitoring programmes to cover the large number of aquaculture farms and key aquaculture environments.

Use of data for improved performance of aquaculture

In general environmental data collected through monitoring is increasingly being used to improve environmental performance of aquaculture. Concerns over the biodiversity issues related to the use of wild *Penaeus monodon* broodstock as well as the introduction of non-local species have led to the development of domesticated technology for white shrimp. Scientific information from research studies conducted by universities and other agencies on potential impacts of shrimp farming in freshwater areas was used for a policy-making decision to ban black tiger shrimp farming in freshwater areas. Control measures from importing countries have also been used as the framework for development of management strategies at the national level so as to assure compliance with importing requirements, such as the extensive residue monitoring systems required for marketing Thai shrimp in EU markets.

Impact of EIA and monitoring on environmental protection

EIA for aquaculture is not a legal requirement. Application of sectoral management measures, such as GAP and CoC, are considered to have had a positive environmental impact at farm and country level. For example, widespread application of the GAP procedure has reduced the use and occurrence of harmful antibiotics in aquaculture.

Feedback and review

Stakeholder consultations on GAP and CoC have been extensive, and have been taken into consideration in the development of certification standards. There is also regular dialogue between government, particularly the Department of Fisheries, and industry stakeholders, in development of policy and addressing the various problems and opportunities that have emerged as the aquaculture industry has grown in Thailand.

Perceptions of stakeholders
The following perceptions are provided as regards EIA and monitoring in aquaculture:

- Policy makers. Cooperation between private companies and governmental organizations is particularly important in Thailand, as several large private companies are advanced in terms of research and development and have an established negotiating position in the markets. Industrial knowledge is essential to support strategic planning and policy development, and has been used for development of sectoral environmental management measures. The importance of environmental issues in international trade ensures that the issues are given high attention by policy makers.
- Hatchery operators. The availability of broodstock and the quality of post-larvae are important for the sustainability of the aquaculture industry. Environmental management not only of hatcheries but also of farms (the buyers of shrimp post-larvae) is critical for hatchery operators. EIA is not perceived as a significant issue of concern. However, the growing use of certification, including various environmental management measures, is considered a concern, particularly the potential costs and benefits of such schemes.
- Farmers. The quality (water, post-larvae and feed) and cost of main aquaculture inputs (energy and feed, in particular) and price are the major focus of farmers. The present low and fluctuating shrimp price in particular is a key factor of concern to shrimp farmers. Farmers are particularly interested in economically efficient production, price and marketing information from processors to be able to plan farming accordingly. In terms of environmental management, many Thai farmers have learnt from past experiences and adapted themselves to be more systematic and concerned more about the environmental consequences along the whole supply chain. For instance, use of prohibited therapeutic agents is no longer practiced due to the concern over the rejection of products. Incentives also apply; for example bank loans require GAP or CoC certification, linking environmental management issues with farm investment. A major concern of farmers at the present time is technical feasibility and financial implications associated with certification schemes, including domestic GAP and CoC and international schemes emerging as requirements from some buyers and importers.
- Processors. Processors are more concerned about the requirements from importing countries, both on food safety and environmental management aspects. The cost implication on food safety implementation is directly related to the production processing activities, excluding the harvesting method that is one of the critical points of control. Processors are concerned with quality from pond to processing factory and with environmental issues which have become one of the marketing factors, especially regarding exporting commodities.
- Consumers. Consumers in Thailand and major importing countries are increasingly aware of food safety and environmental issues associated with aquaculture products. Thailand has responded successfully to consumer needs, and is actively involved in improving quality control and increasingly involved in certification schemes for aquaculture products.

Improvements
The following suggestions are made for improvements in the application of environmental assessment and monitoring in Thailand:

Policy issues
Policy and planning of aquaculture will need to systematically address the roles and responsibilities of governmental organizations in dealing with issues associated with the whole supply chain of aquaculture production activities, and supporting legal

requirements as well as provide opportunities for the involvement of associated stakeholders.

Importing control measures must be considered as the framework of policy analysis, such as standards on food safety control, environmental management, or the new international standard on Food Supply Chain Management (ISO 22000) and international certification/environmental labelling systems.

Marketing strategies must be included in the policy and planning for sustainable aquaculture. Environmental requirements from importing countries also need attention, in terms of technical and economical practicality.

Technical aspects

Improvements in application of EIA principles. Although EIA is not legally required for aquaculture, the tools for environmental assessment (*e.g.* carrying capacity assessments) and monitoring could be more effectively used within the scope of existing legal measures for planning and siting of aquaculture farms. Four areas in particular require attention:

- environmental assessment and monitoring for shrimp farm groups within a particular area, with particular emphasis on cluster management for small-scale farms;
- environmental assessment for development of marine fish farms, including procedures for zoning of aquaculture areas;
- environmental assessment as a planning tool for area-based aquaculture development;
- integrated system of environmental management with application of risk management strategies especially at hatchery and farm levels.

Improvements in application of ecological and human health risk assessment. Adoption of risk based approaches to determine key environmental impacts and focus on key environmental issues of concern in assessment and monitoring. Use of risk analysis in the use of chemical and therapeutic agents in aquaculture to respond to consumer's concern on health risks should be a priority area.

Improvements in application of eutrophication potential modelling. Wastewater is a public concern and modelling of eutrophication potential should be used to set targets for environmental improvements. Modelling on eutrophication potential should be performed at the planning as well as the production stages for better management.

Improvements in application of simulation modelling to estimate the carrying capacity. Use of simulation modelling of environmental footprints associated with the inputs and outputs required to achieve the target production volume along the whole production chain. Eutrophication potential modelling should be conducted especially in areas where the number of farms is already dense so as not to exceed the carrying capacity of supporting ecosystems.

Improvements in use of voluntary instruments and certification. The standards for certification should be technically and economically feasible for all scales of farming operations, with a technical guidance on how farmers can comply and address key environmental risks. Moreover, the scoring and certification systems of both GAP and CoC could be developed further, and possibly simplified, to focus on key food safety and environmental risks. More importantly, public participation in the standard development and certification procedure should be conducted and seminars or workshops provided to farmers for a clear understanding on the implementation and auditing procedures.

Improvements in use of associated market incentives. Declaration of non-use from all producers along the whole supply chain should be encouraged for declaring compliance of non-use of prohibited chemicals and therapeutic agents. The approach will also help in reducing analytical costs.

Improvements in research on optimizing the input levels. Research on comparing different farming systems to identify the environmentally preferred system, and benchmarking the environmental performance of different technology options are needed for sustainable aquaculture development. Alternative protein sources to reduce the demand on fishmeal and fish oil used for feed production should be emphasized, including the optimization of nutrition, digestibility and potential organic loading in wastewater. The potential utilization of aquaculture wastes for recycling should be further investigated. Energy use and management strategies for reduction of carbon emission also require further research.

Improvements in research on feed. Requirements of feed information in terms of ingredients and their sources as well as digestibility level should be considered, and research on fishmeal substitution leading to a low-cost as well as low-pollution feed formula encouraged.

Improvement in GAP and CoC monitoring and auditing procedure. The auditing procedure and monitoring systems of GAP and CoC should be developed for a cost effective and credible approach. There should be more than one auditor in an auditing team and auditors should have an aquaculture or environmental background and receive proper training. The certification standards should be updated periodically to address new environmental risks.

Personnel and facility issues

Capacity building on aquaculture technology and better management practices. Training courses, workshops or seminars to disseminate new knowledge of aquaculture technology as well as better management practices will help to minimize adverse effects on the environment. Moreover, experience sharing among farmers, groups, or even different countries is useful for innovative technology development. Education activities on how to supply information for traceability systems should be conducted together with financial and technical assistances on computerised traceability systems.

Capacity building in auditing for certifiers in both the public and private sectors is also required.

Human and institutional capacity building at provincial level. Laboratory facilities to support the feed quality checking, disease detection and environmental analysis should be upgraded with the ability to test the required parameters according to national and international standards. Provincial fisheries offices also require improvement to at least provide basic services for water quality monitoring of aquaculture areas.

VIET NAM[14]

Requirements

Environmental impact assessment

EIAs have been carried out in Viet Nam since 1993 after the first Law on Environmental Protection was promulgated. Initially, government focused on industrial sectors including existing enterprises and new project investments and aquaculture was not

[14] Contribution by Tran Thi Thu Ngan

initially included. It was subsequently incorporated in 1994 under the Decree No 175/CP dated 18 April 1994.

Annex No 1 of Decree No 175/CP states that "all aquaculture development projects with total areas over 200 ha must prepare an EIA report for appraisal by the Ministry of Science, Technology and Environment (MOSTE[15]) before granting a License of Investment" and "all aquaculture development projects with total areas less than 200 ha must conduct EIA reports to be appraised by the Provincial Department of Science, Technology and Environment before granting the License of Investment".

EIA requirements were further developed through the new Law on Environmental Protection in 2005 and new Decree No 80/CP and new Circular No 08/2006/TT-BTNMT which require EIAs for aquaculture and Strategic Environmental Assessment (SEA) for development plans. The new law comprises a Chapter III "Strategic Environmental Assessment. Environmental Impact Assessment and Commitment of Environmental Protection" regulating EIA for different levels and/or scopes of development plans and projects. Article No 14 of the new law identifies the activities requiring a SEA, including socio-economic development plans at national level, strategies, sectoral development plans, provincial plans, land use plans, forest development, natural resource exploitation in the region or inter-provinces and plans of river-basin integrated management. Whilst aquaculture is not specifically mentioned, it can be argued that the scope of SEA covers aquaculture.

Environmental assessment, monitoring and management of aquaculture activities in Viet Nam are also conducted under the responsibility of the Ministry of Fisheries, now the Ministry of Agriculture and Rural Development[16], as well as other central, provincial and local government agencies. Various legal instruments cover the environmental aspects of planning and operational management of aquaculture activities in Viet Nam.

Administration and responsibilities

At central levels, the Ministry of Natural Resources and Environment (MONRE) has overall responsibility for administration of the environmental impact assessment process. The Department of EIA Appraisal in MONRE has responsibility for conduct of EIA appraisals. At the provincial level, the provincial Department of Natural Resources and Environment (DONRE) plays an important role in EIA appraisal. The DONRE administratively sits within the Provincial administration, and therefore the Provincial People Committees (PPCs) are the final authorities responsible for granting approval. At the district level, the District People's Committees (DPCs) have a role in appraisal of smaller projects, and also follow up monitoring and management activities.

EIA reports must be appraised by the concerned authorities before granting investment licenses or other approvals to proceed with the project. The MONRE and PPCs are responsible for appraising EIAs and SEAs using Appraisal Councils. The People's Committees at district level are responsible for appraising the simpler "Commitment of Environmental Protection[17]". The "Commitment of Environmental Protection" is an EIA type applied for small/household business according to the new Law and Decree on Environment Protection. The new Law on Environmental Protection and new Decree (No 80/2006/ND-CP) and Circular (No 08/2006/TT-BTNMT) also provide for involvement of other relevant government ministries to organize the EIA Appraisal Councils, and be responsible for EIA appraisal.

[15] Now MONRE – the Ministry of Natural Resources and Environment

[16] The former Ministry of Fisheries (MOFI) of Viet Nam was merged into the Ministry of Agriculture and Rural Development (MARD) in late 2007.

[17] The "Commitment of Environment Protection" replaces the "Registration of Securing Environmental Standard".

The Environment Law (Articles No 18 and 24) specify that the project owners and households are responsible for conducting and presenting the EIA to government, in terms of preparation of EIA reports or payment of services for consultancy, and appraisal fees. Normally, the owners of farms/enterprises hire consulting companies, universities and research institutes due to the specialized skills needed and availability of facilities for environmental sampling and analysis.

Recent trends in EIA management in Viet Nam are towards decentralization down to the Provincial People's Committees and District People's Committees and the intention is that Provincial and District authorities will be responsible for environment management during operation of aquaculture farms in their administrative territory in consultation with the Provincial Department of Natural Resource and Environment.

Scope of environmental assessment

The scope and responsibilities for environmental assessment are defined in the Decree and Circular and the specific requirements for conduct of environmental assessment for aquaculture are as follows:

1. Projects requiring SEA. Projects requiring strategic environmental assessment as defined in EIA legislation include:
   - national strategies and plans for socio-economic development;
   - sectoral strategies and national sectoral development plans;
   - provincial or regional strategies and plans for socio-economic development;
   - land use planning, forest protection planning, and other natural resources exploitation and use of natural resources between provinces and regions;
   - development planning of economic zones;
   - integrated planning of river basins crossing provincial boundaries.

The legislation, therefore, could apply to aquaculture, but to date there has been no application of SEA to aquaculture plans or strategies in Viet Nam.

2. Projects requiring EIA. Aquaculture projects are assessed depending on the nature of the aquaculture project, and can be subdivided into three types:
   Group 1: EIA reports that must be appraised by the Ministry of Natural Resource and Environment;
   - projects using a part or whole land or water surface area of national parks, natural conservation zones, biosphere reserves and areas of national heritage, historical and cultural importance;
   - projects involving cutting of protected forest, tidal mangrove forests and special forest with total area over 20 ha, or cutting natural forests with total area over 200 ha;
   - sandy soil aquaculture projects with total area over 100 ha.

   Group 2: EIA reports that must be appraised by Provincial Committees;
   - all projects with potential to cause adverse impacts to water sources of river basin, coastal zones and protected ecosystem areas;
   - all projects using a part of natural conservation, national parks and historical works which are protected by national or provincial governments;
   - intensive/semi-intensive aquaculture projects with total water surface areas of 10 ha and over;
   - extensive aquaculture projects with total water surface areas of 50 ha and over;
   - all other sandy soil aquaculture projects.

   Group 3: Projects that do not require a full EIA, but require a "Commitment of Environment Protection"
   - This type of EIA is applied for all remaining aquaculture projects or household farms. All documents required for the "Commitment of Environmental Protection" will be appraised by District People's Committees.

Public participation and information disclosure

Public participation and information disclosure in the EIA process is regulated in the Circular No 08/2006/TT-BTNMT. The owners of projects must present all the information of aquaculture projects and environmental issues at the commune level, and the EIA reports must receive comments from People's Committees and the Committee of Homeland Frontier at the commune level where the projects are located. This consultation must be done before submitting the EIA to the Appraisal Council.

This process should provide information to communities surrounding the project site and assist authorities in making decisions based on the benefits and concerns of communities and design of mitigation measures. In practice, it is not clear how well this process works. Information is also available on EIA procedures from MONRE and DONRE at central and at provincial levels respectively and guidelines and documents are available.

New farms versus operational farms

EIA is normally required for new farms, but an additional EIA would be required when there are changes in scope of projects and/or the project is carried out after 24 months from the date of EIA approval.

Environmental monitoring

Chapter X of the Law on Environmental Protection regulates environment monitoring and information. There are four types of environment monitoring including:

- national environment status monitoring;
- monitoring of sectoral environment impacts;
- provincial status environment monitoring;
- monitoring of environment impacts caused by all kinds of production activities, including aquaculture and fisheries.

All are conducted under the responsibilities of different agencies at different administrative levels. The national environment status monitoring in aquatic ecosystems is the responsibility of MONRE. The fisheries sectoral management agencies including Ministry of Agriculture and Rural Development (MARD) and Provincial Departments of Fisheries (DARD) are in charge of environment monitoring for the aquaculture and fisheries sector and owners of aquaculture farms are considered as responsible for environmental monitoring at their aquaculture farms. There is, at present, limited sharing of environmental monitoring information between fisheries sectoral agencies and MONRE (or DONRE at provincial level).

The new Circular (No 08/2006/TT-BTNMT) emphasizes environmental management after the EIA report during operation of all projects in general and aquaculture projects in particular. The Circular sets up procedures for implementation of pollution control activities, environmental monitoring, inspection and reporting to the authorities at different levels depending on the scope and environment sensitivity of the project.

TABLE 39

Voluntary instruments for aquaculture in Viet Nam

Voluntary instrument	Origin	Scope
GAP	NAFIQAVED	Shrimp farms, but GAP for catfish under development
COC	NAFIQAVED	Shrimp farms
HACCP	NAFIQAVED, private	Mollusk farms, particularly for EU export
Marine Stewardship Council (MSC) certificate	Private	Ben Tre province clam farming undergoing assessment for MSC certification
Organic shrimp standards	Private	Extensive shrimp farms in one enterprise in Ca Mau province, exported to organic markets in Europe

Voluntary instruments

Apart from the use of EIA, there has been increasing attention in Viet Nam to the control of environmental impacts of aquaculture through Good Aquaculture Practice (GAP) and Code of Conduct (CoC) programmes, to date mainly focussed on shrimp and recently catfish (Table 39). These have been initiated by the Danida-supported Fisheries Sector Programme Support (FSPS) and the former National Fisheries Quality and Veterinary Department (NAFIQAVED, now the National Agro-Forestry & Fisheries Quality Assurance Department (NAFIQAD) under MARD) and the approaches are presently being piloted in some aquaculture areas. A new regulation on mandatory and voluntary certification of aquaculture products was approved in early 2008 and certification standards are under preparation.

The GAP and COC application in pilot farm areas are intended to encourage farmers to implement improved environmental management and monitoring at farm level. The results from pilots have received a good response from farmers and processing plants, and the government plans to expand the programme in the coming years, in terms of number of farmers and other aquaculture commodities.

Practices

Environmental assessment

Although the legal basis for EIA of aquaculture projects is quite strong in Viet Nam, there is still limited application of EIA to aquaculture in practice. The reason is that most aquaculture development in Viet Nam is conducted on a small-scale and therefore has not been subject to formal EIA requirements. This gap is recognized in very recent legal changes, but actual implementation remains a challenge.

EIA reports are available for sandy soil shrimp farming and a large-scale shrimp farming company (ATI) in the central provinces of Viet Nam, and environmental assessment has been conducted on many aquaculture plans produced in coastal provinces. The most common EIA is the provincial lower level EIA conducted for aquaculture projects leading to the Commitment of Environment Protection, and there are many of these. The exact number of reports prepared is uncertain.

A review of district aquaculture plans conducted for UNDP[18] during 2003 revealed that plans do give some consideration of environmental protection, although most lacked separate environmental impact assessments and focus on limited assessments of water quality and treatment, water irrigation, land use and shrimp disease control.

Environment assessment methods for aquaculture are commonly limited largely to water and sediment quality and the methods are changed according to the type and scope of aquaculture projects. The benchmarks for assessing environment quality and impact are based on the Viet Nam environmental standards for water quality, soil quality and some others indicators, otherwise known as TCVNs[19]. Water quality and other environment quality standards are available in Viet Nam and can be used as a basis for assessments of environmental impacts, including TCVNs-1995, TCVNs-1996, TCVNs-1998, TCVNs-1999, TCVNs -2000.

In order to ensure the reliability of assessment, the project owners are required to indicate the source of data and evaluate those data sources. All methodologies used must also be listed in the EIA report, together with an assessment of their reliability. The EIA report must also include the measures required to control environment pollution, together with the estimated costs and timeframe for implementation. All these new requirements of EIA would be helpful in strengthening the effectiveness of EIA implementation in aquaculture development in Viet Nam.

[18] Unpublished report prepared by RIA-1 and NACA
[19] TCVNs are standard documents issued by the Government of Viet Nam

There have been no formal SEAs conducted for aquaculture either, although some local planning and environmental assessment initiatives have been taken under donor funded projects (*e.g.* NORAD in Ha Long Bay) and some universities have developed tools for assessing carrying capacity (Nha Trang University) but these tools have been used only for research and have not yet been applied in more formal planning and EIA procedures.

Environmental monitoring

The recently released EIA guidelines for aquaculture prepared with assistance from Danida specify that the major sampling and techniques follow the TCVN – Environmental Standards, which are harmonised with international standards (ISO). The analytical techniques adopted depend on the facilities available in each laboratory.

Environmental monitoring is a requirement of the EIA but in practice there is very limited follow up on EIA reports or the "lower level" EIA conducted. The environment monitoring methods tend not to be clearly stated in EIA reports, except in a general way by indicating application of TCVNs for sampling and analysis of environment quality parameters.

The Ministry of Natural Resources and Environment is responsible for setting environmental indicators, but unfortunately, such environment indicators have not been issued yet for aquaculture.

Environment and disease monitoring

Within the context of national environmental monitoring for aquaculture, Viet Nam has recently strengthened the environmental monitoring of aquaculture areas and aquatic environments. The Ministry of Fisheries (now MARD) has recently invested in establishment of an "Environmental, Disease Monitoring and Warning System" in the whole country. The system comprises four regional centres located at the MARD Research Institutes for Aquaculture (RIA1, RIA2, RIA3 and RIMF) with responsibilities as follows:

- RIA No 1 is in charge of monitoring of environment and disease for six provinces from Haiphong to Thua Thien – Hue with an emphasis on areas with concentrated aquaculture development.
- RIA No 2 is in charge of monitoring of environment and disease at aquaculture areas of Mekong delta provinces from Ca Mau to Ho Chi Minh City, including Ba Ria – Vung Tau provinces.
- RIA No 3 is in charge of monitoring of environment and disease at aquaculture areas of central provinces from Da Nang to Binh Thuan province in concentrated aquaculture areas.
- RIMF is in charge of monitoring of environment and biodiversity of marine aquaculture areas, fish ports from Quang Ninh – Haiphong to Tra Vinh and four marine protected areas (Cat Ba, Bach Long Vy, Con Co and Phu Quoc).

The monitoring stations are selected with different purposes, as baseline monitoring stations, impact monitoring stations and monitoring stations at water intakes for major aquaculture areas. In general, these stations could provide a valuable service in monitoring environmental conditions in coastal areas. However, at present the detailed operational procedures have not been developed, except for the RIA 1 programme in the Northern provinces, and the link to management actions also requires further work.

The three RIAs have also set up their own monitoring parameters, with some similarity among major parameters and some different parameters to reflect local conditions. To date, there has been limited overall coordination or umbrella programme design, which is leading to concerns about expense in monitoring of unnecessary

TABLE 40
Monitoring parameters for coastal aquaculture

Parameter	Unit	Range or maximum permitted values (where provided)	Analytical method
1. pH	-	6.5–9.0	pH meter
2. Dissolved oxygen (DO)	mg/l	4–8	
3. Biochemical oxygen demand (BOD)	mg/l	20	azide modification by synthetic seawater
4. Chemical oxygen demand (COD)			Potassium permanganate ($KMnO_4$)
5. Suspended solids (SS)	mg/l	70	Filtration using glass fibre filter disc
6. NO_2-N	mgN/l	0–0.005	SMEWW(Standard Methods, 2006) 4500-NO2-B
7. NO_3-N	mgN/l		Cadmium reduction method
8. NH_3-N (ammonia nitrogen)	mgN/l	<0.02 (as NH_3)	SMEWW 4500-NH3
9. Total phosphorus	mgP/l	0.4	Ascorbic acid
10. Total nitrogen	mgN/l		TCVN 5987 – 1995
11. H_2S (hydrogen sulfide)	mg/l	0.01	Methylene blue
12. Oil	mg/l		TCVN 5070 – 1995
13. *Vibrio* spp			Total plate counts
14. Algae			
15. Pesticides			HPLC
16. Heavy metals			Atomic absorption spectrometry

parameters within limited budgets. The programme is constrained by a certain lack of systematic approach and harmony at national level (although the information and data are sent to MARD periodically), which will cause difficulties in data analysis and synthesis of environment and disease status for aquaculture across the whole country in future. The necessary links between data collection, synthesis and early warning systems for farmers have yet to be established. The key water quality and other monitoring parameters currently agreed by MARD are noted in Table 40. These are monitored off-farm.

Frequencies of sampling at the time of preparation of this review are as follows:

- RIMF: minimum of two times a year in selected locations, once in the dry and once in the rainy season. One time per year for corals and marine protected areas (MPA).
- RIA-3: Five times a year in February, April, June, August and November
- RIA-1: No regular monitoring because of limited budgets, but monitoring carried out depending on budget from March to August every year.
- RIA-2: Automatic sampling stations for pH, DO in every 2–3 hours in selected locations. Other environment parameters every three months. Aquatic animal disease sampling planned for every two months.

Major sampling and techniques follow the Vietnamese Environmental Standards (TCVN), which have been harmonised with international standards (ISO). Analytical techniques used in practice depend on the equipment of each laboratory although the TCVN Environmental Standards are widely used for most routine and major parameters. Disease sampling tends to be based on the skills and equipment available, and may vary between laboratories.

Data collection and analysis

There are different channels of data collection in regional centres under the MARD environmental monitoring system:

- one channel is secondary data collection through the provincial Departments of Fisheries (DARD), aquatic resources protection offices, extension centres, farms and meteorological offices;

- the other channel is data collection through sampling and laboratory analysis directly by the coordinating research institutes, or designated provincial authorities.

The data collected through the environmental monitoring system are analysed against the environmental quality standards as set in the TCVN and other indicators for biodiversity and assessment of risk of deteriorating water quality. One problem is that data are interpreted in different ways in different centres creating some problems in interpretation.

The regional centres of RIA-2 and RIA-3 used risk indicators for water quality and disease warning. The regional centre of RIA-2 has good data collection and sampling sites as well as data storage and interpretation, and their monitoring programme was designed methodically and sufficiently detailed to ensure provision of reliable and credible information. Each centre is required to submit quarterly reports, which are sent to MARD following the MARD format. The reporting format is different between regional centres as the frequencies of those centres are different. The written reports summarize the results of each sampling time in such a way that it reduces the value of data.

Another reporting flow comes from the monthly or occasional reports sent from provincial fishery authorities (DARDs). These reports are not regular or obligatory for every province. The regional centre of RIA-2 sends monthly data to all DARDs in the southern provinces. The centre at RIA-3 is sending data to MARDs when they recognize disease issues and obtain data. The regional centre of RIA-1 and RIMF are involved in some information sharing with DARDs, DONREs and farmers. In general, though, there is limited flow of information back to aquaculture farmers as MARD is presently considered the final entity, having all information on environment and disease issues for aquaculture in Viet Nam.

Although environment monitoring is receiving increasing attention by the aquaculture sector of Viet Nam, further work is needed to improve design and coordination and to facilitate better sharing of results. Information sharing is not yet fully open and mechanisms need to be put in place to encourage this practice and better use of the collected data for management.

Personnel and costs

The costs of the (project/farm-level) EIA are borne by the project owner, including costs of conduct and appraisal of the EIA, as specified in the EIA legislation. Any environmental monitoring required in the environmental monitoring plan also requires investment from the project owner/investor.

The costs of environment and disease monitoring are high for small farms in Viet Nam. This is one of the reasons why MARD has invested in establishing a common monitoring system for the whole country. The financial source comes from government budgets. The total budget for four regional centres is 3.55 VND billion (approx USD 221,875[20]) for the year 2007. Recent reviews have shown that the personnel of all regional centres are staff from research institutes, who in some cases have other professional duties. In interviews conducted with some regional centres, it appears that there is insufficient staff to cope with the huge numbers of sampling sites and provinces, and that further investment is required.

Difficulties and constraints in practice

EIA has to date only been conducted for a few large aquaculture projects. The "Registration of Securing Environmental Standards", replaced recently by the Commitment of Environment Protection is a lower level procedure that is increasingly

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[20] 1 USD = Approx. 16,000 Vietnamese Dong (2008)

applied to smaller aquaculture projects with total areas less than 200 ha. Unfortunately, EIAs are not conducted for small aquaculture farms/households that prevail in Viet Nam and together cause significant environment concern. Another implementation concern is that the owners of projects prefer to apply for Commitment of Environment Protection, a shorter and simpler method, rather than full EIA reports, to save costs associated with full EIA requirements.

Although progress has been made with application of EIA for aquaculture development in Viet Nam in recent years, there are a number of difficulties and constraints to implement EIA and monitoring in practice including:

- Limited recognition of incentives for the owners of aquaculture farms to conduct EIA. Lack of enforcement of existing laws, and difficulties in dealing with large numbers of small-scale farmers. The lack of SEA in the aquaculture sector and skilled people to apply this approach is a constraint.
- The perception that EIA work for aquaculture is completed with the EIA report. Most farmers are not aware of the importance of environment monitoring for farming activities.
- The lack of capacity and high costs of environment monitoring in the provinces where the major aquaculture farms are developing, including Ca Mau, Soc Trang, Bac Lieu and others in the southern provinces. These provinces are far from laboratories and environmental monitoring centres in Ho Chi Minh City, and Can Tho university. Farm locations and lack of local services lead to high transportation costs as well as poor quality analytical results.
- The provincial environmental authorities (DONREs) do not have enough capacity for environment monitoring in terms of facilities and human resources. In the northern provinces, only the Quang Ninh province DONRE has set up two environmental monitoring stations for aquaculture. Some provinces could have environmental monitoring centres for periodic monitoring of environmental quality. Most of their activities focus on monitoring the status of environment to prepare the status of environment report, with limited link to management. In the southern provinces where the major aquaculture development occurs, such as Ca Mau, An Giang and Ben Tre, DONREs carry out limited environmental monitoring works for aquaculture, even when this is a major sector bringing income to provincial budgets.
- The capacity of DONREs to conduct environmental monitoring is still weak in terms of facilities, laboratories and skilled staff. Most of the provincial laboratories conduct sampling and analysis of simple parameters such as DO, pH, turbidity and conductivity via portable equipment. Other parameters such as TSS, BOD, COD, nitrogen and phosphorus require more sophisticated laboratories which are available only in Ho Chi Minh City or Can Tho university.

Such constraints limit the use of environmental monitoring in management of the sector and undermine aquaculture farmers' interest and commitment to environmental monitoring and environmental management at provincial and farm levels in most provinces of Viet Nam.

Effectiveness

Technical appropriateness

In general, the EIA for aquaculture development in Viet Nam has been developing in recent years, but practical implementation is still limited. The small-scale sector, the bulk of producers in Viet Nam, is effectively excluded from the system. The exclusion of this part of the sector suggests the approach and/or methods for environmental assessment need to be improved to cover this important part of the sector.

Significant environmental assessment by individual small-scale farmers is an unrealistic option and cluster-based assessment/monitoring approaches might work better. Larger regional approaches, such as SEA, also need to be explored. Environmental risk analysis might also be used to focus environmental assessment on key system risks and ecologically sensitive locations.

Use of data for improved performance of aquaculture
EIA is generally seen as an administrative procedure rather than a management tool. The use of monitoring data to improve performance is extremely limited.

The recently developed environment and disease monitoring system is intended to assist in management, but as yet the links to management measures have not been established. Improvements in connecting this system to management offers scope to provide positive impacts in performance of aquaculture, particularly to protect investments in crowded or highly productive aquaculture areas (*e.g.* catfish farming in the Mekong delta).

The usage of environmental monitoring information for improved management is different in provinces. Some DARDs use information for warning farmers in the case of emergency disease problems. The response to monitoring results depends on the capacity of management of DARDs and DONREs in provinces. The environment monitoring programme for aquaculture has just started and links to management have not yet been worked out.

The application of voluntary instruments like GAPs for small farms and farm clusters in southern provinces is likely to bring higher effectiveness when the farmers and farmers' associations could cooperate to manage the environment. Market incentives for GAP products, and resulting higher prices as achieved in some pilot projects, will also provide an incentive for farmers to engage in such schemes.

Some abandoned aquaculture areas and environment pollution problems in aquaculture zones have led to increasing awareness which has driven recent changes in legal requirements for EIA procedures and practices for aquaculture. These changes need to be built on by further investment in environmental management of the sector by government and private business.

Impact of EIA and monitoring on environmental protection
Most unplanned expansion of aquaculture farms development in Viet Nam in the past years has occurred without effective EIA and environment management. There are several big aquaculture projects that have conducted EIA according to the law, but implementation of environmental management and monitoring has been weak. One concern is that penalties were insufficient to enforce compliance, together with a weakness in capacity and resources of local authorities' for appraisal and follow up monitoring and management.

Feedback and review
Generated data and information are not yet used effectively for improving performance in aquaculture development as the information whilst available to MARD and provincial DARD has probably not been effectively linked to farmers and investors or used for management. However, the information could be used in aquaculture planning in some provinces and districts. There is no mechanism to ensure that the producers/investors can access generated data from the environmental monitoring system.

Investment in environmental monitoring by MARD can be considered as highly positive changes and signals for improved environment management in the future. Although these systems require further development, the outcome of environment monitoring systems is highly appreciated as the first sectoral environment monitoring programme after MONRE, with significant potential to benefit the environment and sectoral development in the future.

Perceptions of stakeholders

Producers, environmental and other NGOs, scientists and others have experienced environmental pollution as well as economic losses as a consequence of pollution and disease in recent years in many aquaculture areas. However, there is doubt that present systems are effective in meeting the challenge in practice.

The new legal framework and policies of MONRE and MARD have set up a system for environmental management of aquaculture in Viet Nam. The practices of provincial and district authorities in implementation of these policies and legislation will have an important influence of environmental management of aquaculture in Viet Nam. Change in perceptions at the local level encouraged and supported by national policy are a key to future progress and improvements.

Improvements

The new law on environment protection and associated regulations emphasize the decentralization of EIA to district level as well as a delegation of environment management responsibilities to different sectors, instead of only MONRE. Further, the use of voluntary instruments such as GAP and COC provide additional incentives towards better environmental management. These measures provide a strong legal foundation for future improvements in the environmental management of the sector although a number of improvements are required to support implementation:

- EIA appraisal, management and inspection at the district level needs more trained staff. To date, there has been limited preparation of human resources for this new function leading to lack of capacity in terms of quality and quantity.
- MARD also has new environment management tasks, especially in EIA appraisal and environment monitoring. This means that MARD has to prepare the necessary human and financial resources. Although the regional centres (RIAs) are using available staff for environment monitoring, there is a need to strengthen staff at the MARD level in the Department of Science and Technology.
- The Commitment of Environment Protection will be required for small farms and could be carried out at district level while environment monitoring and pollution control will not be easily implemented by most small farms. This situation encouraged MARD to establish the environment, disease monitoring and warning programme for the aquaculture sectors. Unfortunately, the budget is insufficient for the task (for example, regional centre of RIA-3 received around VND 100 million for environment monitoring in 2007, enough for staff salary, power and water, but with limited fieldwork).
- It is necessary to have a mechanism of information sharing and service provision to finance environment monitoring rather than only looking for government budget. Sharing costs between the private sector and government is required. Regional centres for example could be providing environment monitoring services for aquaculture enterprises and subsidize a part of the cost to small farms.
- Improvements are needed in the MARD environment and disease monitoring system; in particular a more consistent umbrella programme design in terms of methods, purposes of the programme and feedback to management. Among four regional centres, the regional centres of RIA-2 and RIA-3 have been designed methodically and specifically with baseline sampling sites, impact sampling sites and common regional sampling sites, but the lists of parameters are too broad. Prioritization of parameters lists through some reconnaissance monitoring is necessary to cut out unnecessary parameters after a period of monitoring. Too many sampling parameters cause high costs under limitations of budget and skilled staff.
- National indicators are needed for trend analysis and management decisions in the environment, disease monitoring and warning systems, which could help

MARD respond to an emergency situation. National indicators are needed for environmental factors, aquatic animal disease pathogens and biodiversity.
- To avoid bias in results and warnings to farmers, there should be a standardization of data interpretation and periodic calibration or inter-laboratories testing between regional centres to improve the quality of monitoring results and response to situation.
- It is also necessary to appraise the efficiency and effectiveness of existing EIA and monitoring requirements and practices, as stipulated in both obligatory and voluntary instruments, with particular emphasis on an effort to expand GAP and BMP application for existing farms to improve environment management in Viet Nam aquaculture. However, enforcement of new requirements of EIA for aquaculture should be strongly encouraged and supported.
- Use of SEA in aquaculture should be further explored to see its practicality and effectiveness in environmental management of the aquaculture sector, for assessment at the farm cluster level and for regional planning.

OTHER COUNTRIES[21]

In other Asian countries/territories, there are varied requirements and application of EIA and environmental monitoring to aquaculture, as described briefly below.

Bangladesh

The following description is based on FAO's NALO for Bangladesh (FAO, 2005-2008 NALO Bangladesh). The Environmental Protection Act (1995) aims to protect the environment and to control and mitigate environmental pollution. It establishes the Department of Environment (DoE) under the Ministry of Environment and Forest (MoEF), headed by a Director General. The main strategies under the act include, *inter alia*, declaration of ecologically critical areas and restriction on the operation and process which can be carried out or cannot be initiated in the ecologically critical areas, environmental clearance for industrial enterprises and projects, setting water quality standards for particular uses of water and promulgation of acceptable limits for discharging and emitting waste, as well as the formulation and definition of environmental guidelines.

The act has been implemented by the Environment Conservation Rules (1997), according to which all new industries and projects must apply for an Environmental Clearance Certificate. Industries are classified according to their potential impact on the environment into four categories - Green, Orange-A, Orange-B and Red. Green industries are automatically granted a certificate. Orange categories must submit considerable further information and plans, and may be subject to field inspection. The highly polluting categories Orange-B and Red must in addition conduct a detailed EIA and prepare environmental management plans satisfactory to DoE. Schedule 1 of the Rules provides the category classification of most common industries but does not include aquaculture projects. The processing of fish, prawns and shrimps is categorized under Orange-B.

EIAs have been conducted for several donor funded fisheries and aquaculture projects, but they are not applied for domestic investments in aquaculture or its associated infrastructure.

Cambodia

Environmental impact assessment legislation has been put into place in Cambodia (UN, 2002), but it is understood that to date EIA has not been applied to aquaculture, because most aquaculture development is small-scale.

[21] Compiled by Michael Phillips and Koji Yamamoto (NACA)

Following the December 1996 Law on Environmental Protection and Natural Resource Management, the Council of Ministers has approved a Sub-Decree in August 1999 (No: 72 ANRK.BK) that stipulates that EIAs are required on various kinds and scales of projects (Cambodia, 1999). The sub-decree specifies the general requirements, procedures and responsibilities, and instructed the Ministry of Environment to formulate rules and guidelines for implementation. The sub-decree identifies various (mainly large scale) projects that require an EIA. However, these projects do not include aquaculture (fishing ports are the only specified fisheries related activities requiring an EIA).

The Department of Fisheries, with support of the International Fund for Agricultural Development, conducted a review of fisheries and aquaculture development and environmental impact in 2001 (Cambodia DoF, 2001). The review provides a useful insight into the environmental management of aquaculture in Cambodia, and future requirements. The review emphasized the importance of EIA, but no specific recommendations were provided on application of EIA in the aquaculture sector.

Myanmar

There are no provisions for EIA of aquaculture in Myanmar (FAO, 2005-2008 NALO Myanmar), although the environmental aspects of aquaculture siting and operations are to some extent covered under specific aquaculture and fisheries laws. The Law relating to Aquaculture No. 24/89 regulates the application for aquaculture leases and licences and the Marine Fisheries Law No 9/1990 and the Freshwater Fisheries Law No 1/1991 contains various licensing requirements for aquaculture activities, including a number of directives with a bearing on food safety.

Lao People's Democratic Republic

The 1991 Constitution provides that "all organizations and citizens must protect the environment and natural resources: land, underground, forests, fauna, water sources and atmosphere" (FAO, 2006-2008 NALO Lao People's Democratic Republic). A general duty to protect the environment is also established in the Law on Agriculture.

The main authority in the field of environmental matters is the Science, Technology and Environment Organization (also translated as Science, Technology and Environment Agency). Under the terms of the Environmental Protection Law (1999), any project or activity that may potentially affect the environment is subject to an Environmental Impact Assessment. An Environmental Impact Report must be submitted according to the rules issued by the Science, Technology and Environment Organization, as implemented by the relevant sectoral authority. Hence the Ministry of Agriculture is in charge of implementing the EIA rules concerning aquaculture projects.

Nepal

Environmental impact assessment is legally required in Nepal, according to Environment Protection Act, 1996 and Environment Protection Regulation 1997. The main thrusts of the Act and the Regulation are pollution control and environment assessment. Aquaculture as such is not included in the regulation, and to date as far as is known no EIAs have been applied to the development of aquaculture in Nepal.

Pakistan

No information available.

Republic of Korea

The Basic Environmental Policy Act (1990) sets down the objectives and directions in the Republic of Korea for the country's environmental preservation policies and provides the framework for environmental protection (FAO, 2005-2008 NALO

Republic of Korea) . Under this act, a large number of other laws have been enacted that relate to specific areas of the environment, such as the Nature Environment Conservation Act (1991) which aims, *inter alia*, to prevent the extinction of endangered species through conservation of biological diversity. The environmental laws and regulations are administered and implemented by the Ministry of Environment (MoE), which is the primary government agency responsible for the overall protection of the country's environment.

The Act on Assessment of Impacts of Works on Environment, Traffic, Disasters and Population (1999) generally deals with the assessment of impacts on the environment, among others. Projects that are subject to an assessment of impacts include, *inter alia*, the development of water resources, the utilization and development of rivers, the cultivation and reclamation of public waters as well as other projects that have an impact on, *inter alia*, the environment, and which are further prescribed by Presidential Decree. The act generally puts environmental impact assessments under the management of MoE, which may further determine the items of EIAs. With respect to projects that affect the marine environment, the act imposes an obligation on MoE to consult with the Ministry of Maritime Affairs and Fisheries.

The Republic of Korea has well-established planning and zoning systems for aquaculture and a more detailed analysis of these systems would be more widely relevant to the region.

Sri Lanka

The National Environmental Act (1980, as amended in 1988) makes provision for the protection, management and enhancement of the environment, for the regulation, maintenance and control of the quality of the environment, and for the prevention and control of pollution (FAO, 2004-2008 NALO Sri Lanka). The Act establishes the Central Environmental Authority for its administration. Part IV C of the Act requires the approval of "project approving agencies" for "prescribed projects" following an Initial Environmental Examination (IEE) or EIA. According to the National Environmental (Impact Assessment) Regulations (1992), the Ministry of Fisheries and Aquatic Resources is considered a "project approving agency" for fisheries matters.

The "prescribed projects" that require an IEE or EIA are further defined by an Order, issued in 1993 under section 23Z of the National Environmental Act. They include the following aquaculture projects:

- aquaculture development projects over 4 ha, if located wholly or partly outside the coastal zone as defined by the Coast Conservation Act;
- projects that involve conversion of forests covering an area exceeding 1 ha into non-forest use, if located wholly or partly outside the coastal zone as defined by the Coast Conservation Act;
- aquaculture projects irrespective of their size and irrespective whether or not they are located within the coastal zone, if located within environmentally sensitive areas (as further defined by Part III of the Order).

The procedure to be followed by the "project approving agencies" is regulated in the National Environmental (Procedure for Approval of Projects) Regulations (1993). The applicant should submit as early as possible preliminary information on the project as requested by the agency, which must acknowledge receipt of such preliminary information in writing within six days. In consultation with the Central Environmental Authority, the agency decides within 14 days whether an IEE must be held or within 30 days whether an EIA must be held. The agency sets the terms of reference for the IEE or EIA. In drafting the terms, the agency may take into consideration the views of state agencies and the public. Upon receipt of the IEE or EIA report, the agency can grant approval (upon specified conditions) or refuse approval (with reasons).

The North Western Province has its own statutes and authority for environmental matters. The North Western Province Environmental Statute (1990) provides for the establishment of the North Western Province Environmental Authority, which acts as "project approving agency" and administers IEEs and EIAs for the North Western Province, including aquaculture.

A recent review (Samarakoon and Rowan, 2008) provides an analysis of the environmental assessment practices in Sri Lanka, with a particular focus on ecology. Two-thirds were IEE surveys, while the remaining third advanced to full EIA. A representative sample of 130 EAs (both IEEs and full EIAs) spanning a broad range of project types, scales and environmental settings was selected to evaluate the quality of the ecological investigations within the published environmental impact statements (EISs). These were assigned into five classes of "explanatory power", on the basis of their scientific content in relation to survey, analysis and reporting of ecological interests. Within most EISs, the ecological impact assessment (EcIA) was restricted to the lowest two categories of ecological assessment, *i.e.* tokenistic presentation of reconnaissance-level species lists without further analysis of the development implications for individual organisms or communities. None of the assessments reviewed provided statistically rigorous analysis, which would be required if ecological impact studies are to include quantitative and testable predictions of impact, which could then be followed up by appropriate post-impact monitoring programmes. Attention to key local issues such as biodiversity or ecosystem services was also notably underrepresented. The paper concluded that despite the existence of a sound legislative framework in Sri Lanka, the analysis contained within EISs generally fails to convey meaningful information to the relevant stakeholders and decision makers involved in protecting ecological interests and promoting sustainable development.

The paper further concluded that introduction of strategic environmental assessment is considered an important tool to strengthen the institutional capacity of Sri Lankan government authorities to implement current regulations and, in particular, to combat the cumulative effects of incremental development.

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ANNEX A

EXAMPLE OF EIA REPORTING FORMAT FROM CHINA, HONG KONG SAR

CONTENTS OF AN ENVIRONMENTAL IMPACT ASSESSMENT (EIA) REPORT (China, Hong Kong SAR. 2008)

<u>EXECUTIVE SUMMARY IN ENGLISH AND CHINESE</u>

- Summary of main issues, findings, conclusions and recommendations

<u>INTRODUCTION</u>

- Background of the project
- Purpose of the EIA study
- The approach

<u>DESCRIPTION OF THE PROJECT</u>

- Key project requirements
- Site location and site history
- Nature, scope and benefits of the project
- Size or scale, shape and design of the project
- Project timetable and phasing of the project
- Means by which the project will be implemented
- Any related projects
- Type, scope, scale, frequency and duration of the construction, operational or decommissioning (if relevant) activities
- Background and history of the project, including considerations given to different options, and the project's different siting or alignment
- Description of scenarios with or without the project

<u>ENVIRONMENTAL LEGISLATION, POLICIES, PLANS, STANDARDS AND CRITERIA</u>

- Applicable environmental ordinances and regulations
- Applicable government environmental policies and plans
- Applicable environmental standards and criteria
- Other references

<u>DESCRIPTION OF THE ENVIRONMENT</u>

- Baseline environmental conditions
- Environmental trends

<u>DESCRIPTION OF ASSESSMENT METHODOLOGIES</u>

- Assessment methodologies, assumptions and criteria, including sample calculations and input and output files of a typical model run for all mathematical modelling

<u>IDENTIFICATION OF ENVIRONMENTAL IMPACTS</u>

- Potential environmental impacts including the types, characteristics and estimated quantities of emissions, discharges, wastes, potential risks, disturbances or displacement associated with the activities relating to the project during construction, operation and decommissioning phases
- Description of resources or receivers which are vulnerable to change or environmental impacts

<u>PREDICTION AND EVALUATION OF ENVIRONMENTAL IMPACTS</u>

- Prediction of environmental impacts (including beneficial or adverse; direct or indirect; short term or long term; reversible or irreversible; transboundary; cumulative)

- Evaluation of predicted environmental impacts against applicable environmental legislation, policies, plans, standards and criteria

MITIGATION OF ADVERSE ENVIRONMENTAL IMPACTS

- Measures to eliminate, reduce or remedy adverse environmental impacts

DEFINITION AND EVALUATION OF RESIDUAL ENVIRONMENTAL IMPACTS

- Definition and evaluation of net environmental impacts with mitigation measures in place

ENVIRONMENTAL MONITORING AND AUDIT

- Need for and scope of monitoring and audit
- Environmental monitoring and audit requirements, if found to be necessary, and the related environmental monitoring and audit programme

CONCLUSIONS AND RECOMMENDATIONS

SCHEDULE OF RECOMMENDED MITIGATION MEASURES

- A schedule of all mitigation measures recommended in the EIA report, listing out what the mitigation measures are, by whom, when, where and to what requirements, and including the key environmental monitoring and audit requirements

APPENDIX

- Responses to comments received

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Review of environmental impact assessment and monitoring in aquaculture in Europe and North America

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Telfer, T.C., Atkin, H. and Corner, R.A. 2009. Review of environmental impact assessment and monitoring in aquaculture in Europe and North America. In FAO. Environmental impact assessment and monitoring in aquaculture. *FAO Fisheries and Aquaculture Technical Paper*. No. 527. Rome, FAO. pp. 285–394.

ABSTRACT

Environmental impact assessment (EIA) methods and practice, monitoring procedures and legislation were reviewed for aquaculture in Europe and North America. Compilation of this review has allowed comments on both the effectiveness and suggestions for improvements to be given. All freshwater and marine species, other than marine salmon culture, are considered within this review, including where possible invertebrates and fish species grown in the Europe and North America. Countries with considerable quantities of aquaculture production have been highlighted; Canada, Czech Republic, France, Greece, Hungary, Italy, the Netherlands, Poland, Spain, Turkey, the United Kingdom (UK) and the United States of America (USA). In some of these countries the implementation of the EIA process is more refined and important in terms of aquaculture development than others.

Despite the commonality of EU Directives, the review highlights that within the EU the mechanisms for EIA and monitoring of environmental impact as a statutory regulatory requirement are extremely inconsistent, ranging from a very precise or prescriptive EIA and monitoring requirement to no requirement at all. EIA implementation often depends on complicated and bureaucratic processes within individual countries, rather than implementation of a system which regulates the development of aquaculture effectively or allowing development of a common policy through effective implementation of EU Directives.

In North America, the requirements and practice for the EIA and environmental monitoring process are different and often multi-layered, with conflicts arising between local, regional, state and federal legislation. Which legislation takes precedence varies with location and type of aquaculture development. Adherence to codes of conduct and best practice developed between the industry and authorities are often considered as important as statutory regulation.

Though the level of activity varies between locality, country and region, implementation of the EIA and environmental monitoring process in aquaculture is seen as expensive and, to some extent, unnecessary in its present complicated form. The process, in general, would benefit by targeting the information required to manage impacts and estimate

capacities rather than to follow a defined procedure on a "one size fits all" basis. This targeted information may vary with cultured species, location and type of development. In addition, the contribution of information from environmental monitoring should also be optimized to be more appropriate.

In general, the EIA process for aquaculture developments is poorly implemented, with little transparency or focus. In particular, there is still much work to do to improve its use and implementation in farm-level, sectoral and environmental management. Clearly, better cooperation between regulatory bodies and aquaculture management has lead to more efficient, workable and less bureaucratic forms of environmental regulation and codes of practice being developed in some countries. In turn, this has lead to more successful and sustainable aquaculture developments.

CONTENTS

Acronyms and abbreviations

General

ASMO	Environmental Assessment and Monitoring Committee
ASP	Amnesic shellfish poisoning
BAP	Best aquaculture practices
BOD	Biological oxygen demand
BMP	Best management practice
CIHEAM	International Centre for Advanced Mediterranean Agronomic Studies
CCRF	Code of Conduct for Responsible Fisheries
CoP	Codes of Practice
CoC	Codes of Conduct
CPP	Consultation and Public Participation
DSP	Diarrhetic shellfish poisoning
DSS	Decision Support Systems
EEC	European economic community
EEZ	Exclusive economic zone
EFF	European Fisheries Fund
EIA	Environmental impact assessment
EIS	Environmental impact statement
EMPA	European Mollusc Producers Association
EQS	Environmental Quality Standards
ES	Environmental statement
FAO	Food and Agriculture Organization of the United Nations
FCR	Feed Conversion Ratio
FEAP	Federation of European Aquaculture Producers
FIFG	Financial Instrument for Fisheries Guidance
GIS	Geographic Information System
HDPE	High-density polyethylene
HELCOM	Helsinki Commission (marine conservation of the Baltic Sea)
IAIA	International Association for Impact Assessment
ICES	International Council for the Exploration of the Sea
ICZM	Integrated coastal zone management
MPA	Marine protected area
MRL	Maximum Residue Level
NALO	National Aquaculture Legislation Overview
NASO	National Aquaculture Sector Overview
NGO	Non-governmental Organization
NSP	Neurotoxic shellfish poisoning
OECD	Organisation for Economic Co-operation and Development
OSPAR	Oslo and Paris Conventions (marine conservation)
PARCOM	Paris Commission (reduction of toxic chemicals)
PCB	Polychlorinated biphenyls
PEC	Predicted environmental concentration
PNEC	Predictable no effect concentration
POM	Particulate organic matter

PROFET	EU sixth Framework Fisheries and aquaculture research dissemination initiative
PSP	Paralytic shellfish poisoning
RID	Riverine inputs and direct discharges
SEA	Strategic Environmental Assessment
SIA	Social Impact Assessment
SME	Small and medium enterprise
SPM	Suspended particulate matter
TP	Total phosphorus
TSS	Total suspended solids
TECAM	Technology of Aquaculture in the Mediterranean Network
UNEP	United Nations Environment Programme
UK	United Kingdom
UNESCO	United Nations Educational, Scientific and Cultural Organization
USA	United States of America
VIA	Visual impact assessment
WWF	World Wild Fund for Native

France

AMM	Market Licence (Autorisation de mise sur le marché)
DSV	Department of Veterinary Services
INRA	Institut national de la recherche agronomique
REMI	Microbiological Network
REPHY	Phytoplankton Network
RNO	National Observation Network

Greece

AD	Administrative Directives
FGM	Federation of Greek Maricultures

Italy

API	Italian Fish Farming Association

Netherlands

RIVO	Netherlands Institute for Fishery Research

Poland

MARD	Ministry of Agriculture and Rural Development

Spain

APROMAR	Association of Marine Aquaculture Producers

Turkey

DSI	General Directorate of State Hydraulic Works
GDAPD	Directorate of Agricultural Production and Development
GDAR	General Directorate of Agricultural Research
GDOS	General Directorate of Organization and Support
GDPC	General Directorate of Protection and Control
MARA	Ministry of Agriculture and Rural Affairs
SPA	Special Protection Areas

United Kingdom

AZE	Allowable Zone of Effect
BTA	British Trout Association
CAR	Controlled Activities Regulation
CE	Crown Estate
CEFAS	Centre for Environment Fisheries and Aquaculture Science (England, Wales and Northern Ireland)
COPA	Control of Pollution Act
DARD	Department of Agriculture and Rural Development for Northern Ireland
DEFRA	Department for Environment, Food and Rural Affairs
DEPC	Department for Environment, Planning and Countryside (Wales)
DSFB	District Salmon Fishery Boards
EA	Environment Agency
EHS	Northern Ireland the Environment and Heritage Service
EN	English Nature
FRS	Fishery Research Services (Scotland)
LPA	Local Planning Authority
PPC	Prevention of Pollution and Control
SAMS	Scottish Association for Marine Science
SARF	Scottish Aquaculture Research Forum
SEAFISH	Seafish Industry Authority
SEERAD	Scottish Executive Environment and Rural Affairs Department
SEPA	Scottish Environment Protection Agency
SNH	Scottish Natural Heritage
VMD	Veterinary Medicines Directorate
VPC	Veterinary Products Committee
WFD	Water Framework Directive

Canada

AAA	Aboriginal Aquaculture Association
ACES	Aboriginal Certification of Environmental Sustainability
BC	British Colombia
CDC	Conservation Data Centres
CEAA	Canadian Environmental Assessment Act
CEPA	Canadian Environmental Protection Act
CFIA	Canadian Food Inspection Agency
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CSSP	Canadian Shellfish Sanitation Program
CWS	Canadian Wildlife Service
DFA	Nova Scotia Department of Fisheries and Aquaculture
DFO	Federal Department of Fisheries and Oceans Canada
EMP	Environmental Monitoring Program
EQD	Environmental Quality Definition
FEAI	Federal Environmental Assessment Index
NWPA	Navigable Waters Protection Act
RA	Responsible Authority
VEC	Valued Ecosystem Components

United States of America

CAAP	Concentrated Aquatic Animal Production Programme
ELG	Effluent Limitations Guidelines
EPA	United States Environmental Protection Agency

FDA	Food and Drug Administration
FWS	United States Fish and Wildlife Service
INADS	Investigational New Animal Drug Exemptions
FSA	Federal Joint Subcommittee on Aquaculture
HACCP	Hazard Analysis and Critical Control Points
NEPA	National Environmental Policy Act
NOAA	National Oceanic and Atmospheric Administration
NPDES	National Pollutant Discharge Elimination System
NRCS	Natural Resources Conservation Service
PEIR	Project Environmental Impact Report
USEPA	United States Environmental Protection Agency
USDA	United States Department of Agriculture

Summary

This review concentrates on the environmental impact assessment and environmental monitoring as well as environmental regulation methods in aquaculture in Europe and North American countries. It gives special consideration to four areas related to Environmental Impact Assessment (EIA) and monitoring in aquaculture: (1) the requirements, (2) the practice, (3) the effectiveness and (4) suggestions for improvements.

The requirements and practice for EIA and environmental monitoring are reviewed specifically for Canada, Czech Republic, France, Greece, Hungary, Italy, the Netherlands, Poland, Spain, Turkey, the United Kingdom (UK) and the United States of America (USA). The EIA and regulatory practice referred to will cover the species: Atlantic cod, turbot, Atlantic halibut, carps, seabass, seabream, tilapia, barramundi, blue mussels, scallops, oysters, abalone, freshwater salmonids, channel catfish, eel, sturgeon and seaweeds. Some of these may be considered as a group as environmental assessment practice is often consistent between species.

The review shows that despite common legislation in the European Union (EU) for implementation of the EIA process for impacts on aquatic systems, execution of this legislation within different EU countries is inconsistent and often is dependent on existing and sometimes highly bureaucratic frameworks. In some countries there is no specific requirement for an EIA process for aquaculture development. For North America, particularly within the United States of America, environmental regulatory legislation is different and often conflicting depending on whether it is considered under federal, state, or county regulation requirements; which of these takes precedent is often dependant on the locality of the aquaculture facility.

It is clear from the review of the legislative frameworks for environmental assessment that the collection of monitoring data is expensive and hence it needs to be targeted at the information necessary to manage the impacts that are deemed significant as part of the EIA. Such aspects should be identified as early as practicable within the EIA process, to optimize the contribution of monitoring data to the EIA implementation and follow up. Monitoring involves designing an appropriate survey, collecting, analyzing and reporting the data and establishing a link to improve impact management.

In general it has been found that the closer the links between the regulatory system and actual practice at fish farms, the fewer objections, difficulties and misunderstandings occur. In many locations throughout Europe for example there appears to be an unnecessary and high level of bureaucratic involvement in the development of aquaculture activity. There is poor transparency in the implementation of EIA legislation as it relates to aquaculture, and differential treatment of aquaculture sectors, which may be an impediment to aquaculture development. For example in Greece, the Netherlands and Italy, the introduction of a central "aquaculture policy" could greatly assist the development of the industry in relation to other uses of the coastal zone.

Various suggestions are made to increase the quality and effectiveness of EIA reports and therefore enhance the number and extent of environmentally beneficial modifications to aquaculture projects, including: investigating alternatives, improvement of the screening process, adopt formal scoping requirements to encourage early recognition of the need for modifications, carry out formal checks on the quality of EIA reports, strengthen wider consultation and public participation, research into various aspects of the EIA process to meet particular national and local circumstances.

Environmental monitoring methods throughout the two regions studied mostly collect data for comparisons to Environmental Quality Standards (EQSs) which have been set at a threshold where significant environmental impact occurs. New methods of combining key, but easy to measure, environmental parameters to give an overall simplified index have been developed. This is a good approach and should be investigated further. It has the advantage of simplicity, reduced requirements for sampling, reduced potential for error, ease of sampling, reduction of costs of sampling and greater potential for effective comparison between studies and monitoring programmes. However, caution should be used in implementing such indices as they give little information that can be used for comparative research to further existing knowledge of the impacts of aquaculture on the ecosystem. Therefore, distinction should clearly be made between collection of data for environmental regulation (comparison with EQSs) and collection for scientific research into the impacts of aquaculture on the ecosystem, from which the indices can be developed.

Introduction

Over the last 40 years aquaculture production and the diversity of species used under culture conditions has expanded rapidly throughout the world. Inland aquaculture is dominated by either pond culture or tank-based culture of fish species. Marine aquaculture is more varied in nature, encompassing fish, shellfish and algal species. Within the context of this review the development of intensive aquaculture within inland freshwater and marine systems of Europe and North America is showing considerable growth (FAO, 2006; Olin, 2006; Rana, 2007; Subasinghe *et al.*, 2000).

Congruent with this increase in development has been an associated increase in the environmental regulatory framework and assessment procedures used to control the activity. Pre-development assessment of potential aquaculture impacts (through Environmental Impact Assessment) and post-development assessment of actual impacts (through monitoring) have increased in prominence. These controls vary across nations and even within nations. In many countries, relatively well-defined control encompasses procedural as well as defined environmental quality standards and in others the regulatory framework is less well defined. This is reflected in this review by the variable content within the country-specific evaluations.

The principles of EIA and monitoring developed out of an increasing understanding that all development activity required some assessment of the likely impact of that development. Such regulations and procedures were initially developed, in the early 1960s, out of a need to enforce large-scale projects (e.g. power stations, construction) to take account of environmental considerations (Institute of Developing Economies, 1994). Only subsequently have EIA and monitoring filtered through to smaller scale projects, including aquaculture. In the context of aquaculture, some of the countries in this review have specifically related laws and regulations to EIA and monitoring for aquaculture, but others have no specifically dedicated outcomes to aquaculture production, with more general regulation concerning EIA and monitoring prevailing. This too is reflected in the country-specific evaluations.

This review concentrates on the Environmental Impact Assessment (EIA) and environmental regulation methods defined for freshwater salmonid production and for other non-salmonid species as grown in Europe and North American countries. The review will address the complexity and effectiveness of the EIA and monitoring processes in environmental regulation of aquaculture. The review will take form of an assessment of:

1. the regulatory requirements as they are defined and used to assess the environmental impact of aquaculture;
2. the practical application of EIA and monitoring requirements;
3. the effectiveness of the application of the EIA and monitoring requirements;
4. the provision of suggestions for improvements in the application of EIA and monitoring requirements.

The requirements for environmental impact assessment and environmental monitoring are generally built within regional and national legislation, rather than having a standard format across all areas. Even within the EIA process, which has common principles, the implementation of the principles on aquaculture development tends to be specific through its implementation within regional and local legislation. As a result it is necessary to conduct the majority of the review on a country-by-country basis.

This review focused on a selected number of countries in Europe and North America, including the Czech Republic, France, Greece, Hungary, Ireland, Italy, the Netherlands, Poland, Spain, Turkey and the United Kingdom in Europe; and Canada and the United States of America in North America.

The review will encompass non-salmonid species including Atlantic cod, turbot, Atlantic halibut, carps, eels, seabass, seabream, tilapia, barramundi, blue mussels, scallops, oysters, abalone and seaweeds. Salmonids (trout, arctic charr and salmon) grown in freshwater are also included. Marine-based salmon culture has been identified as a special case because of the scale of production, particularly in northern Europe and North and South America, and the review of EIA and monitoring in salmon aquaculture has been covered by Wilson *et al.* (this volume).

Most of the marine and freshwater species in this review are not necessarily separated under legislation and are therefore grouped in their country-specific review. As a general rule environmental impact assessment and standard monitoring methodologies are often consistent between species and this is reflected in the layout presented here.

In establishing that both environmental impact assessment and monitoring, as it relates to aquaculture, will be the primary focus of this review, it is worth at this early stage defining what these mean in some detail.

ENVIRONMENTAL IMPACT ASSESSMENT

Environmental Impact Assessment (EIA) can be defined as "a process for identifying the likely consequences for the biophysical environment and for man's health and welfare of implementing particular activities, and conveying this information, at a stage when it can materially affect their decision, to those responsible for sanctioning the proposals" (Munn, 1979).

This remains a broad definition and does not encapsulate more recent discrete and related disciplines, such as visual impact assessment (VIA) and social impact assessment (SIA). This is important as the EU Directive on EIA (EU Directive 85/337; amended as EU Directive 97/11; European Commission, 1985; 1997) specifically includes an assessment of the impacts on these aspects. The IAIA (1999) define Environmental Impact Assessment as "The process of identifying, predicting, evaluating and mitigating the biophysical, social and other relevant effects of development proposals prior to major decisions being taken and commitments made" and perhaps more readily covers the impact process. Importantly it is not an abstract "procedure" to be followed, more a process that establishes the potential environmental (and visual and social) implications of a particular development, in this case aquaculture. What the EIA process cannot define is the specific procedures that should take place to achieve the assessment and this may lead to variations in how the process is interpreted.

This process often results in a documented submission that takes account of both statutory and non-statutory requirements. Although not exhaustive the statutory requirements include those covered under legislative and regulatory processes and procedures (at a governmental level); whilst non-statutory requirements are those mandated through voluntary instruments such as codes of practice, best practice guidelines and certification schemes, where these exist (at stakeholder level). The documented submission, referred to as an environmental impact statement (EIS), therefore encapsulates the relevant effects of development activity. Consideration of best management practices (BMPs), such as consideration of multiple alternative sites (Steinmann, 2001), outlining monitoring and management plans (if not a requirement of local legislation) and the use of reliable predictive models (Glasson *et al*., 1999) as quality indicators, are also included within the EIS. All environmental *risks* are considered and normally a *risk matrix* would be constructed to summarize the risks of all related processes and practices, mitigation measures and even monitoring plans associated with that risk.

This EIS is passed onto appropriate decision-makers who, in consultation with both statutory and non-statutory participants, will judge the impacts, effects and mitigations measures and either approve, approve with conditions or not approve the development.

As a concept the process of environmental impact assessment (EIA) came about in the United States of America in 1970, implemented under the United States National Environmental Policy Act (NEPA, 1969). Prior to this it existed only in rudimentary form. Multilateral organizations have also adopted many of the principles of EIA, including, for example, the Organization of Economic Cooperation and Development (OECD), which adopted recommendations concerning EIA within its constituent states in 1974. Since then many other countries have implemented their own EIA procedures, including Canada (1973), Australia (1974), the Netherlands (1981), Japan (1984) and the European Community (1985). This list is far from exhaustive but the combination of these implementations means the system of environmental assessment has now been adopted by more than 100 countries throughout the world. For further reference, UNEP has produced a training resource manual on EIA (Sadler and McCabe, 2002).

In this review both generally applicable and aquaculture specific environmental impact assessment processes will be reviewed.

MONITORING

The process of environmental impact assessment defines the relevant likely effects of development activity but an important strand, post-development, is the requirement for post-authorization monitoring. Monitoring, however, refers to the conduct of procedures to assess the state of the system. Generally this often means it is limited as an assessment of the environment.

It is used to evaluate changes to the system and in this context monitoring can be used to evaluate the changes against a measured pre-development state. This might manifest itself as an assessment of the sediment characteristic before an aquaculture facility is located and again after it has been in operation for some pre-determined time. More often, however, monitoring of aquaculture is used to assess state against some pre-determined quality standards that are regarded as needing to be maintained.

Environmental monitoring is key to the implementation and follow-up of an EIA, as other components of the EIA process are dependent on the scope and type of monitoring information that is provided. The primary aim of monitoring is to provide information that will aid impact management; to help achieve a better understanding of cause-effect relationships and to improve EIA impact prediction and mitigation methods. Environmental monitoring is used to (after Telfer and Beveridge, 2001);

- establish baseline conditions (a critical reference point);
- measure the impacts that occur during project construction and operation;
- check compliance with agreed conditions and standards;
- verify the accuracy of impact predictions and determine the effectiveness of mitigation measures.

The practice, methods and procedures for monitoring in the various countries under consideration is, in itself, an onerous task and the detailed elements of this are not dwelt on during this review. Regulations and monitoring requirements used in marine aquaculture throughout Europe were reviewed and compared in 1999 by the MARAQUA project (Fernandes *et al*., 2000). Across the countries under consideration there will be material differences in the type and number of samples required to assess benthic impacts in sea cages, for example, while such data may not be relevant at all for production in ponds and raceways. Similarly chemical parameters may be of less importance in marine systems because of its large buffering capacity, but are highly important in pond and raceway culture, where water exchange is limited. Consideration of methods and procedures are further complicated by amongst others:

- the monitoring infrastructure available and by the skills and training of environmental and other specialists;
- the variation between farms, which depends on the particular provisions applied to the consent to operate any particular farm, which in themselves stem from the evaluation of the site-specific environmental impact assessment;
- the variation in monitoring requirements depending on the size of the farm operation;
- the variation in monitoring requirements depending on whether one is considering freshwater or marine systems;
- the variation in culture practice between species, which causes variations in specific requirements. For example, the type of chemicals permitted for treatment of disease;
- the relative differences in composition of and therefore the assessment of impacts between differing feed types used to culture the various species.

It was not therefore feasible to evaluate specific monitoring practices to this level of detail, although during the review, where specific information sources are available, these are referred to. It is nonetheless important to consider that the monitoring of aquaculture is a necessity to ensure environmentally sustainable practices. It encompasses the formal measurement of the effects of operations on the environment and of vital importance, is the need to subsequently alter practices to reduce impacts where these are observed.

STRATEGIC ENVIRONMENTAL ASSESSMENT

Strategic environmental assessment (SEA) is a relatively new concept and aims to fill the gap between single project developments and cumulative affects resulting from large, complicated or multiple development activity (European Commission, 2001). In Europe SEA was enacted through Directive 2001/42/EC (European Commission, 2001) and legislated into community country law during 2001. At present it relates specifically to planning related issues, such a regional and local plans and development plans and in this context confers specific requirements of national and local governments to consider the environmental implication, alternatives and measurable targets related to large and complicated infrastructure developments. SEA is not yet a requirement for aquaculture development.

Although not exclusively so, the EIA process generally considers the implications of specific development activity. For aquaculture, SEA may be used at a strategic level to evaluate, for example, the cumulative or multiplicative effects of development of a few aquaculture sites in a single waterbody or in a single area. In this context there is potentially a multiplication of effects that may not be evaluated fully by individual EIAs. As far as is known such a strategy does not apply to aquaculture at present, though in future SEA is likely to become an increasingly used process to evaluate environmental effects.

Requirements and practices

The assessment of the pre- and post- development impact at an aquaculture production site will:

- incorporate the need to comply with legislative requirements;
- incorporate the need to comply with regulatory controls, where these exist;
- encompass standard monitoring methods but that are adapted for the particular development and its likely impact;
- have to take account of non-statutory requirements mandated through voluntary instruments such as codes of practice, best practice guidelines and certification schemes, where these exist.

The degree to which these are incorporated will depend on country-specific implementation strategy. In this section the country evaluation is limited to the legislative requirements for the EIA process and the implementation of monitoring processes but also encapsulates the non-statutory requirements as mandated through voluntary instruments such as codes of practice, best practice guidelines and certification schemes, where these exist. It is therefore an assessment of both requirements and practice.

INTRODUCTION – EUROPE

In most European countries there are two requirements that are enshrined in environmental legislation, applicable equally to EU member states and accession countries. They are (a) the EIA process as part of the initial planning/development application for an aquaculture system, and (b) statutory monitoring of the environment to assess impacts that may occur. Environmental impact assessment requirements for developments encompass the implementation of processes and procedures enshrined within regional, national and local legislation. Although these will specify whether or not aquaculture development is included within the legislation, these higher level guiding rules are not specifically defined for aquaculture development. An example of this is the EU Directive on Environmental Impact Assessment (EU Directive 85/337; amended as EU Directive 97/11), introduced in 1985 (European Commission, 1997; 1985). It identifies aquaculture as a Schedule 2 controlled activity, which means aquaculture development comes under the legislation and an aquaculture development will need to be evaluated to determine whether an EIA will be required or not. But the legislation itself is not aquaculture specific. The EIA Directive also defines a format for an EIA and the minimum information it should contain. This is given in Annex 1.

There is a variable implementation of the EIA Directive requirements into country legislation. The EIA Directive was fully implemented in all countries in 2002, despite being enacted under European legislation as early as 1985. Often this was done through variable pieces of legislation, in some countries specifically referring to aquaculture and in others not. The European legislation was enacted in the UK, not through one corresponding piece of legislation but through a series of laws covering a range of activities. One of these included a specific form of aquaculture production, through the Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999, which covers fish production (HMSO, 1999). This sets down the criteria at which an EIA would be necessary for finfish production in marine waters. The legislation does not cover inland waters, or other forms of aquaculture production, which rely instead on the more general EIA requirements. There is also other non-EIA legislation which continues to play their part in managing these other aquaculture elements. Thus whilst not all aquaculture is covered by the EIA legislation there is still a degree of control.

Whilst trigger points for the EIA process to be enacted for aquaculture development are identified in the 1999 UK act, such as maximum farm size where the requirement does not apply, it does not lay down the criteria on how impacts are to be measured and evaluated. Although criteria may not be explicitly identified within particular countries EIA legislation, it is not unreasonable to assume that the environmental impact of a cage site for finfish growth, for example, would require an evaluation of likely impacts on local water and sediment quality as part of the EIA process. Thus, even where precise requirements are not laid down, the need to investigate can trigger the implementation of standard collection and processing requirements, useful to the EIA and monitoring requirements.

The broad regulatory framework (e.g. EU EIA Directive 97/11/EEC) is translated into countries legislation in a more or less general format, as identified above. In addition, countries may manage aquaculture development through a series of policy-driven documents that aquaculture companies are expected to comply with. In general, policy-driven assessment requirements are developed through the various ministries and government departments who are responsible for aquaculture and thus have sufficient weight without the need to enshrine it in law. Whilst in most cases the onus is on the applicant to provide appropriate data (e.g. France, Spain and UK), often the onus would appear to be on the government institutions to carry out the monitoring requirements directly (as would appear to be the case in Poland and the Czech Republic, for example). Thus these policy documents and procedures form another entwined layer in the process of impact assessment of aquaculture and cannot often be materially separated from higher-level enactments.

The next level of administrative infrastructure will often be the more detailed methods. These identify the procedures that need to be followed in order to comply with both the legislation and need for information on which to base a decision. These are not policies or legislative requirements, but procedural documents that provide the methodological approaches, data processing and analysis requirements necessary. One example of this is Scotland. Government agencies have provided very detailed handbooks on all aspects of marine finfish aquaculture, its management, consent and control, and to a lesser extent, also on related aspects of freshwater aquaculture. Much of this information is not law, but nonetheless provides the basis for the day-to-day management of the industry. This is often very detailed, down to what and how many sediment samples should be collected, processed and numerically analysed. At the other extreme, aquaculture specific EIA regulation in some other countries is not readily available. Coincident with this, it was also difficult to establish the practical methods and procedures used for both the EIA evaluation and subsequent monitoring requirements. Many of the countries in this review fit between these two extremes.

The disjointedness identified above is reflected in the following country-specific reviews. It has proved difficult to uncouple the legislative requirements at the higher level (e.g. EIA legislation) with those related to aquaculture specifically and those of the practices that are required to achieve those EIA and monitoring requirements. For this reason this section of the review couples two of the elements required of this review, that of establishing the *requirements* and the *practices*.

Beyond government department legislative and policy requirements there are also so-called "soft-law" elements governing aquaculture development. These include non-statutory requirements as mandated through voluntary instruments such as codes of practice, best practice guidelines and certification schemes.

Specific non-statutory components will be reviewed on a country-by-country basis. There is, however, a need to review non-statutory organizations and review code definitions. At a world level the FAO present a Code of Conduct for Responsible Fisheries

(CCRF) (FAO, 1995). Article 1 of this document outlines the scope, identifying that "The Code provides principles and standards applicable to the conservation management and development of all fisheries". In particular, aquaculture development is referred to under Article 9.

In Europe the two key aquaculture organizations representing the production sector are the Federation of European Aquaculture Producers (FEAP) and the European Mollusc Producers Association (EMPA)[1]. These organizations are themselves formed from country trade organizations, examples of which include the Czech Fish Farmers Association – Rybarske Sdruzeni Ceske Budejovice in the Czech Republic, the FGM – Federation of Greek Maricultures in Greece and the British Trout Association (BTA) in the UK. Both European organizations have either Codes of Practice (CoP) or Codes of Conduct (CoC), which outline in broad terms the promotion of aquaculture production in a sustainable and considerate manner (e.g. FEAP, 2000). Some, though not all affiliated organizations endorse these general principles through their own CoPs. Such CoPs tend to be more specific and detailed, often outlining how specific farm related tasks (e.g. treatment of waste, fish welfare and environmental issues) will be managed to minimize environmental, ethical and social impact. Membership by specific companies to country-based trade organizations is determined through their willingness and agreement to comply with these principles and who themselves often maintain their own operating procedures that encompass the wider trade organization requirements. Thus there is, in many countries, a continuous linkage between farm-based operations and the wider community.

Globally, other non-statutory bodies include the World Wildlife Fund (WWF) for example, who are promoting work on aquaculture certification (WWF/CCI, 2008), and who generally also certify whether specific farm procedures comply with a certification scheme (Panda mark), which buyers and consumers can then base their purchase decisions on. The Marine Stewardship Council currently does not cover aquaculture, but this remains under review for possible future certification. There are many such schemes throughout Europe and other regions, including single-issue certification schemes, process-related certification, general environmental certification schemes and eco-labelling, which are reviewed comprehensively by FAO (2005). In collaboration with a wide range of stakeholders, FAO has been promoting the development of technical guidelines on aquaculture certification (FAO, 2008). Specific country-based schemes will be identified in the following country reviews, where this can be determined.

Overall, certification schemes and eco-labelling act to provide guidelines for responsible aquaculture practice and development, either more generally or more targeted towards specific aspects of aquaculture production. Within this context they do impact the nature and content of Environmental Impact Assessment and monitoring studies, but they do not necessarily specifically impact the conduct, development and execution of Environmental Impact Assessment and monitoring *per se*.

INTRODUCTION – NORTH AMERICA

Many of the characteristics of the organization of Environmental Impact Assessment and monitoring requirements identified above hold true for North America. However, North American legislation on aquaculture and implementation of the EIA process is based specifically around individual country (United States of America and Canada in this review) and regional or state legislation. As a result they do not have the commonality of EU collective legislation or guidelines against which to act. There is thus a relative inconsistency in format and implementation. What has become apparent through this review is that the application for consent which encompasses the EIA

[1] See http://ec.europa.eu/fisheries/cfp/governance/acfa/members_en.htm

process and for example responding in the application to how a farmer will operate under a Best Management Practices scheme, tends to be synonymous. It remains unclear whether EIA is specifically required in the North American context for aquaculture developments.

Certification of aquaculture products in North America predominates through the Aquaculture Certification Council who offers certification of “processes” through application of the Global Aquaculture Alliance Best Aquaculture Practices (BAP) standards (GAA/ACC, 2008). Although process-driven there is no specific reference to EIA or to monitoring, but the latter is implicit to some extent as a result of the need to identify whether the farm operator has complied with certain environment standards. One example is for channel catfish, which lays down some broader principles concerning use of feeds and affect on environment, but also specifies some more specific parameters such as minimum water quality standards

In Canada, governmental legislative requirements concerning aquaculture and other non-statutory mandates are also supplemented to take account of the values of First Nation communities. The Aboriginal Aquaculture Association (AAA) requested a feasibility study for an Aboriginal Certification of Environmental Sustainability (ACES) programme (Cross and Brackett, 2006), which at the time of writing remains in development.

EUROPEAN EIA AND ENVIRONMENTAL MONITORING REQUIREMENTS AND PRACTICES

Czech Republic

Context

Aquaculture production in the Czech Republic is relatively small compared to other European countries, and is entirely based on freshwater systems, particularly ponds. Pond culture has a 1000-year history and many of the ponds used today have been in existence for hundreds of years (Rybarske Sdruzeni Ceske Budejovice, 2008). There are 14 species of aquatic animals cultured, including trout in raceways and ponds, native species such as tench and pike and non-native species such as catfish and sturgeon. Only carp species are produced in significant numbers accounting for 88% of the total fish produced (Globefish, 2008). Carps are nearly all produced in semi-intensive pond culture, with maize added to supplement normal feeding on plankton and invertebrates (Rybarske Sdruzeni Ceske Budejovice, 2008). Common carp has been grown increasingly since the mid 1980s and some 20 000 tonnes were produced in 2005 (FAO, 2006-2008. NASO Czech Republic). All aspects of aquaculture production (collectively called a fishery because of ponds supporting role to fisheries in general) are managed through municipal authorities of municipalities with expanded competence, regional authorities and the Ministry of Agriculture, within the framework of legal requirements.

EIA implementation

The combination of the relative longevity of pond culture production in the Czech Republic and its general lack of development in recent years means that there has been little or no implementation of the principles of Environmental Impact Assessment in the aquaculture sector. The Czech Republic introduced EIA regulations originally through its 1992 National Council Act No. 244/1992. This act made no explicit mention of pond culture, aquaculture or fisheries. This Act was replaced by Act No. 100/2001 Coll. (further amended by Act No. 93/2004 Coll.) in accordance with EU EIA legislation (Czech Republic, 2004.) Changes to the act and the corresponding development of a comprehensive set of EIA procedures resulted from a PHARE Twinning Project (Karbowski and Honova, 2004).

Within the 100/2001 Coll. Act, all activities listed under Category I will always require an EIA to be carried out. Category II activities are those that initially require a less demanding "Fact Finding Procedure" (Figure 1) that may or may not result in a full EIA. Under this context it is the government "competent authority" that carries out the assessment (Czech Republic, 2004), being required to:

"………….find out whether and to what degree the project can seriously affect the environment and the population. In this, it shall employ the following criteria characterizing, on the one hand, the project itself and the relevant area of interest and, on the other hand, the consequent significant potential impacts on the population and the environment.

I. CHARACTERISTICS OF THE PROJECT

The parameters of the project must be considered particularly in relation to

1. *the size;*
2. *accumulation of its impacts with the impacts of other known projects (being implemented, prepared, considered);*
3. *exploitation of natural resources;*
4. *waste production;*
5. *pollution of the environment and impacts on public health;*
6. *risk of accidents, particularly in relation to the proposed use of substances and technologies.*

II. LOCATION OF THE PROJECT

The parameters of the territory that can be affected by the project must be considered particularly in relation to

1. *the previous use of the territory and priorities of its sustainable use;*
2. *the relative number, quality and regeneration ability of natural resources;*
3. *the ability of the natural environment to bear loads; with special emphasis on*
   a) *territorial systems of ecological stability of the landscape;*
   b) *specially protected territories;*
   c) *nature parks territory;*
   d) *important landscape features;*
   e) *territories of historical, cultural or archaeological importance;*
   f) *densely populated areas;*
   g) *territories burdened above the acceptable level (including old burdens).*

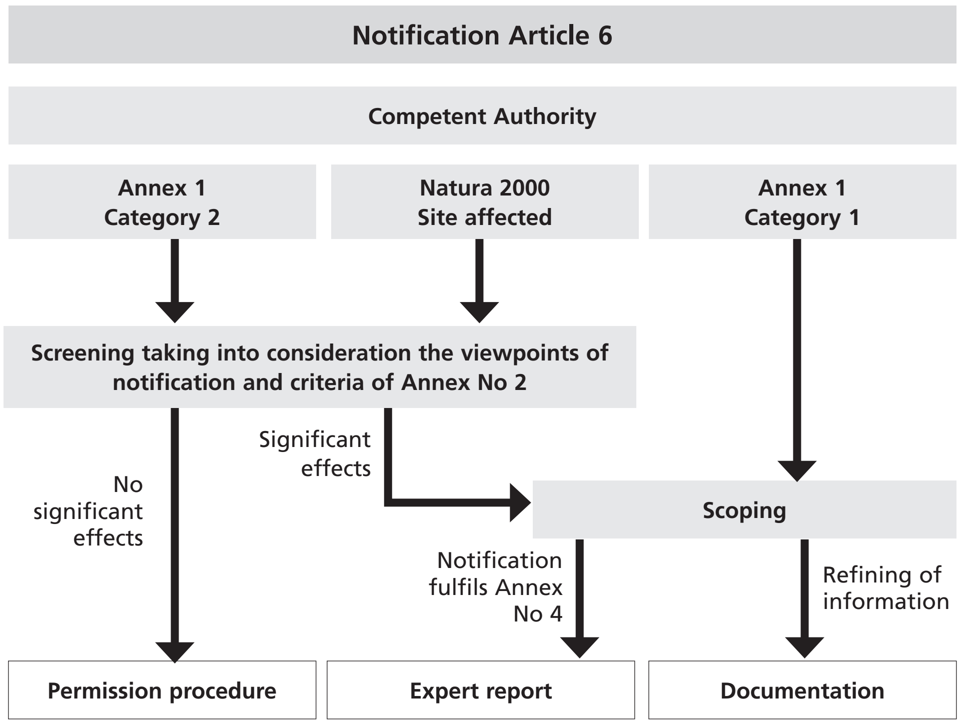
III. CHARACTERISTICS OF EXPECTED IMPACTS OF THE PROJECT ON THE POPULATION AND THE ENVIRONMENT

Potential important impacts of the project must be considered in relation to the criteria set forth in points I. and II., particularly in relation to

1. *the extent of impacts (the affected area and population);*
2. *the nature of impacts in relation to trans-boundary extent;*
3. *the magnitude and complexity of impacts;*
4. *the probability of impacts;*
5. *the duration, frequency and reversibility of impacts."*

Source: Czech Republic, 2004. (Annex 2 to Act No. 100/2001 Coll.)

FIGURE 1
Fact Finding Procedure for Category II activities under Czech Republic EIA legislation, Act No. 100/2001



Source: Czech Republic, 2004.

Fish farming is listed as a Category 2 activity and thus has to undergo a fact finding procedure, but then only under certain circumstances. Specifically, the only reference to fish culture in Act No. 100/2001 Coll. is in Annex 1, Category II, item 1.6 "Ponds intended for fish breeding with a stocking of fish over 10 t of live weight" (Czech Republic, 2004)

The aquaculture sector was under state-ownership prior to 1993, and was privatised progressively between 1993 and 1995 (Globefish, 2008). It was not possible to determine the extent of the ownership of ponds used to culture fish. Currently up to 110 owners/organizations produce the majority of the fish (Globefish, 2008). It was probable that under this transfer of ownership few, if any, EIAs were carried out. There is no evidence that government authorities had retrospectively required EIAs to be carried out on existing farms. The use of EIA may increase in the future as larger farms are developed, or perhaps more intensively cultured species are grown. Approval of a pond development under the new Act would mean that the permissions associated with it would last 30 years, and thus EIA would be an important evaluation of the environmental sustainability of any particular farm.

Post-development monitoring

A comprehensive assessment of post-development monitoring conducted in the Czech Republic between 1993 and 2001 was carried out by Braniš and Christopoulos (2005). Although this was not specifically related to aquaculture, their assessment of post-development monitoring of impacts, showed there to be little or no requirement or practical application of post-development monitoring. It appears that there are no substantive regulations concerning the monitoring of pond systems and no apparent assessment required or carried out to consistently record the post-development impact of pond culture.

The Czech Republic has issued a new version of the State Environmental Policy (Ministry of Environment of the Czech Republic, 2004), though there is no specific mention of aquaculture within the policies on protection, use and monitoring of Czech Republic waters. Here water policy is based on the Water Framework Directive (EU Directive 2000/60/EC). Protection of water quality is based on the reduction of pollutant input into receiving waters through preventative techniques and includes promoting dredging of fish farms. Permanent monitoring of organic pollutants and toxic metals in surface and ground waters and protection of the natural environment and landscape when carrying out water works is required. Water works in this context do not specifically include fish culture and this does not translate into definitive monitoring of culture sites.

France

Context

France is one of the largest aquaculture producers in Europe. Aquaculture is dominated by bivalve shellfish production with 118 120 tonnes of Oyster (*Crassotrea gigas*) and 66 250 tonnes of mussel (*Mytilus* sp.) cultured in 2005 (FAO, 2007). The farming of fish is an increasing sector, though still relatively small, and is dominated by freshwater culture of rainbow trout (32 353 tonnes in 2005). Mariculture of fish has a comparatively small production with seabass and seabream production at 3 913 tonnes and 1 778 tonnes in 2005, respectively. However, this is considered the most important area for aquaculture expansion, particularly on the Mediterranean coast.

Regulatory framework

The Ministries of Agriculture and Ecology and Sustainable Development are responsible for aquaculture in France. At the national level the implementation of the EU EIA Directive was conducted through Book 1 of the French Environmental Code via decree No. 77–1141 (LEGIFRANCE, 2008; FAO, 2006-2008 NALO France). Within this context article 2 of Law No. 76–269 concerning the protection of nature stipulated that an EIA was required the development of marine-based farms considered classified installations. In reality not all marine developments fall within this category and shellfish production is specifically exempted through decree 53–578. Therefore a part of the French aquaculture sector falls outside the requirements of the EU EIA Directive 337/1985.

Inland freshwater aquaculture – application procedure

There are two procedures for establishing an inland aquaculture facility within French legislation. An initial application for a permit or concession is required followed by an operating authorization. These are separate requirements and are under the auspice of different authorities, which themselves have different needs.

In development of an inland aquaculture site on private land, the developer must apply for a *permit*, whilst *concessions* are given for development on government-owned land. These permits/concessions are denied to farming activities that may threaten fish populations in surrounding waters. In particular, the developer must consider means of limiting the free movement of farmed fish into the water course by preventing escapees and minimising the potential for water pollution that would put fish life in jeopardy.

Applications for a permit or concession must contain the following information:

- name of applicant;
- location of development and map of the area;
- evidence of permission to undertake the aquaculture activity from the landowner or appropriate authority;
- detailed plan of the aquaculture system;

TABLE 1
Thresholds for declaration and authorization of land-based fish farms in France

Production capacity	Freshwater salmonid farm
> 10 tonnes/year	Authorization
500 kg to 10 tonnes/year	Declaration
Production capacity	**Other freshwater fish farm**
> 20 tonnes/year	Authorization
5 to 20 tonnes/year	Declaration

Source: after CONSENSUS, 2005b.

- description of the production method, goals and harvesting methods;
- description of measures to be used to ensure there is no danger to local fish populations through fish movement and water quality;
- drainage procedures;
- duration of operation and evidence of the financial viability of the applicant.

Applications are evaluated by a Prefect, who typically takes two months to either reject the permit application outright or to move to the authorization phase when a full EIA or Environmental Impact Notice (Notice d'impact) is required.

The authorization of land-based fish farms depends on type and production capacity (Table 1). There is no requirement for authorization if the production capacity is lower than the minimal threshold, culture of certain species must be reported to the Departmental Directorate of the Veterinary Services (CONSENSUS, 2005b). Land-based farms fall under the objectives of the EU Water Framework Directive (2000/60/EC).

Marine aquaculture – application procedure

Two different concessions are available for finfish mariculture depending on whether the land/water area is owned by the state or privately. The permit applications are addressed by the Department of Maritime Affairs, which is part of a local authority. Part of their duty is to pass the application to the statutory consultees for comment (see Figure 2). Subsequent advice given by the consultees is compiled by the Commission for Maritime Aquaculture and then given to the local prefect. It is the local prefect who is responsible for granting or declining the permit. In the case of mariculture sites the permits are granted for a maximum of 35 years and are only then subject to review. Although not yet within the EIA process there is an onus on the applicant to show that there are likely to be no or manageable risks of impact over both the short, intermediate and longer term, before a permit is granted.

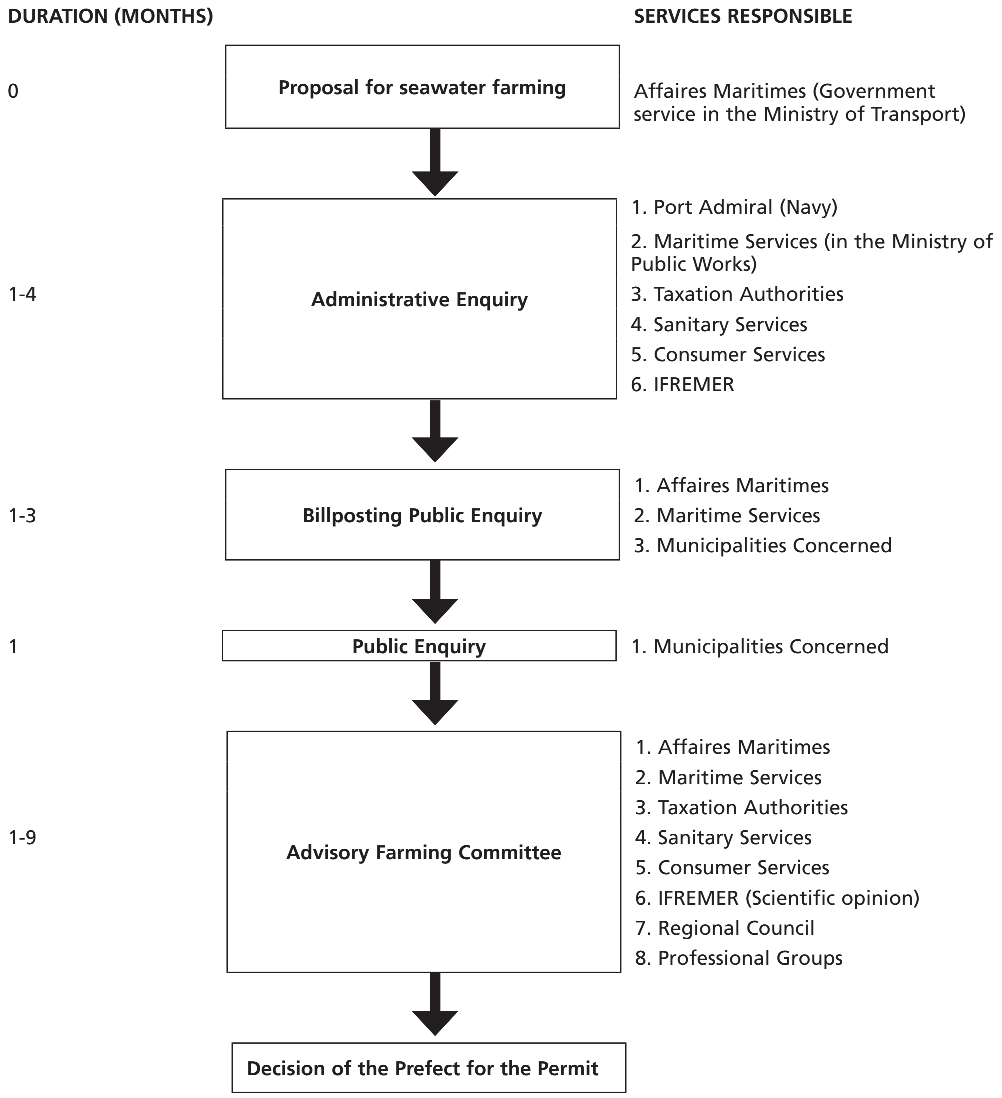
The authorization phase follows the procedures given in Figure 3 and requires environmental analysis, either in the form of an EIA or an environmental notice. An EIA must be presented as part of the application process within two years of initial application for the following aquaculture projects:

- salmon aquaculture farms;
- aquaculture farms with scientific or experimental functions;
- new fish farms with an annual production > 20 tonnes or a water surface of >3 ha, or existing farms wishing to exceed these limits.

In France the EIA requirements conform to that specified under EU Directive (97/11/EC; see Annex 1) and must include:

- a non-technical summary;
- the rationale for the aquaculture development;
- a baseline analysis of the initial state of the site and its surrounding environment;
- an assessment of likely direct and indirect impacts of the development on the environment;
- the mitigation, elimination or compensation measures proposed by the applicant;
- a critical description of a monitoring plan to assess the project's impact.

FIGURE 2
Legal procedures for obtaining a permit for development of maritime property. The first column represents the duration of steps (after Dosdat and Pomelie, 2000)



Inland freshwater aquaculture – environmental standards and monitoring

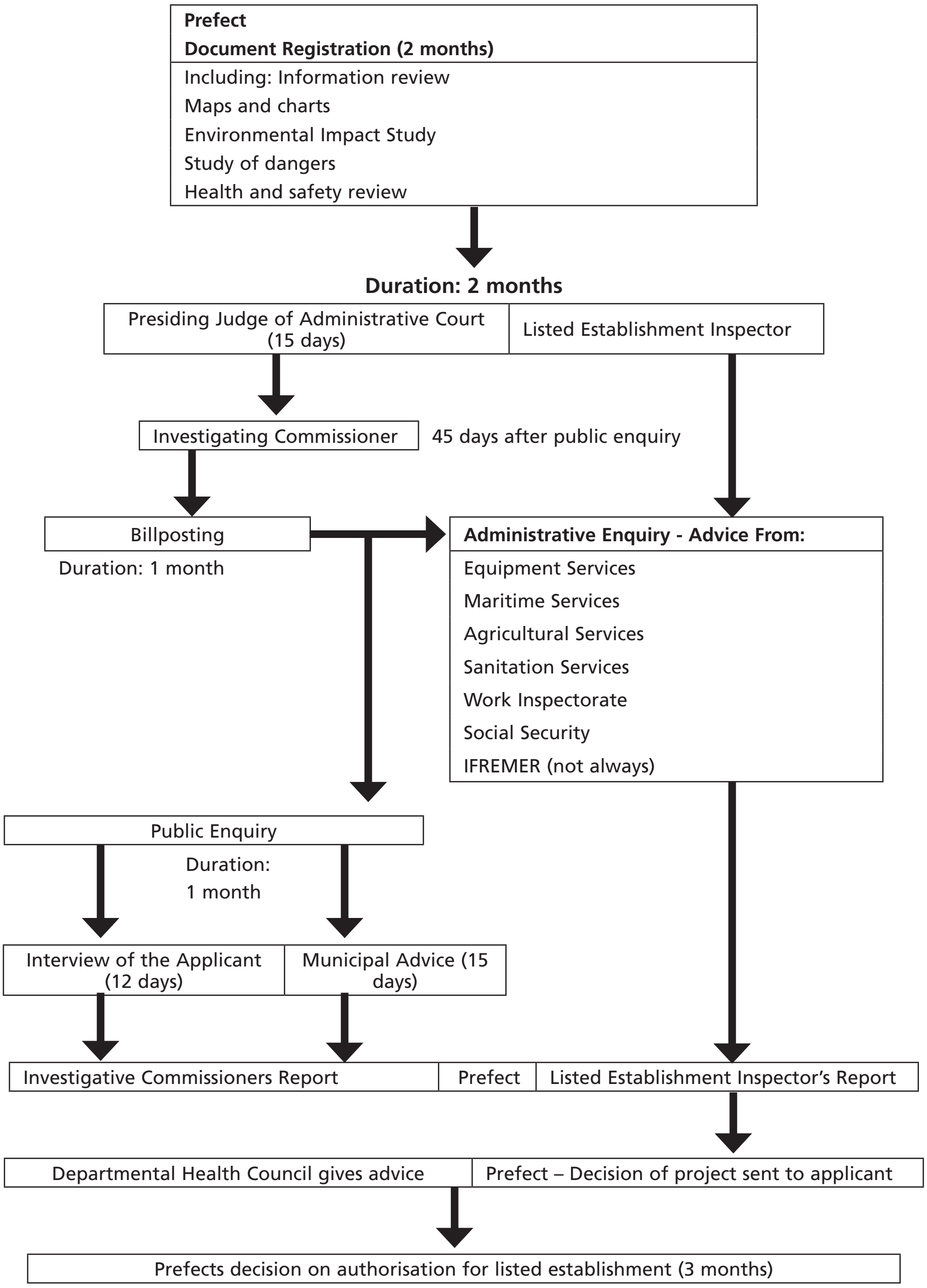
In fish farming there are no compulsory environmental standards so the amount of fish production is balanced against an acceptable level of environmental impact. This is a decision taken by discussion between stakeholders, under the auspice of the Departmental Health Council. In freshwater culture systems there are local standards of water quality (see Table 2).

TABLE 2
Environmental quality standards applied to land-based fish farms.

Parameter	Value
Total ammonia M (mg/L)	<0.5
Nitrate N (mg/L)	<10
Phosphate P (mg/L)	<1
Oxygen saturation (%)	>70
Suspended solids (mg/L)	<25
Faecal coliforms (No/ 100 mL)	<2000
Heavy metals	No standard

Source: after Dosdat and Pomelie, 2000.

FIGURE 3
Legal procedures for authorization to operate a fish farm likely to cause environmental impact (after Dosdat and Pomelie, 2000)



The principal pollutants in the water exiting a freshwater culture system are suspended matter, nitrogen (N) and phosphorus (P). Water agencies in France use these three water quality parameters to establish the pollution tax of fish farms.

Mariculture – environmental standards and monitoring

The most common schemes for monitoring mariculture involve a survey of following parameters, carried out every six months (bi-annually):

- sediment quality

- redox potential
- benthic fauna
- organic carbon levels

Methods for analysis of these parameters tend to require specialist knowledge or equipment. Sediment quality generally relates to oxygen level, whether the sediment contains chemical tracers of environmental degradation such as methane and sulphur dioxide and whether the sediment grain size has changed as a result of farming activity. Benthic fauna identification requires extensive knowledge of taxonomic features and is a specialist skill. Measures of organic carbon require appropriate equipment to measure loss-on-ignition. Thus these requirements for environmental monitoring are carried out by specialist firms.

Also water quality in the vicinity of the cages is typically monitored by the farmers themselves, with measures of dissolved oxygen, ammonia levels and microbiological monitoring carried out at a maximum of three month intervals. Dissolved oxygen and ammonia are more readily measured, with the availability of probes allowing measures to be taken every day, if necessary.

Monitoring of other data

The fish farmer must keep production (biomass and feed used) and fish treatment records. This includes accidental events such as mortalities and escapes. These are monitored by the Department of Veterinary Services (DSV), which has the statutory power of inspection audits.

The use of veterinary products within the environment is regulated. The legislation is applicable to antibiotics, vaccines and food additives used in fin-fish culture. Since 1997 it has been compulsory under EU Directive 92/18 that there are no residues from these veterinary products retained in the fish flesh, that the products do not affect the environment and that in order to obtain a market licence, (an AMM, or Authorisation de mise sur le marché) then such effects have to be measured. The study is carried out on behalf of the manufacturer of the chemicals (at their expense) and is divided into three phases (Dosdat and Pomelie, 2000):

Phase 1:	Chemical analysis to determine the presence of a given chemical (or metabolite) in the natural environment after treatment of the fish. This gives the predictable environmental concentration (PEC).
Phase 2:	Phase 2 is always carried out in the marine environment, it is designed to define the predictable no effect concentration (PNEC). Data on the elimination kinetics of the substance in different environmental conditions are required and the acute toxicity levels for fish, shrimp larvae and algae must be determined. When the PEC/PNEC ratio is higher than one, Phase 3 must be implemented.
Phase 3:	Further investigations are necessary, for example monitoring gradual changes in the sediments, or the dispersion in the environment and the effect on free bacteria. These studies are often performed in a mesocosm.

In France, aquatic veterinary products are only available though prescription from a registered veterinary surgeon. Recently, a temporary utilization authorization has been launched in order to allow fish producers to use some veterinary products that have intermediary status before being authorized through an AMM.

There are no specific environmental monitoring or EIA requirements for shellfish in France. However, three named “networks” are monitoring (i) water quality (RNO, National Observation Network), (ii) water microbiology (REMI, Microbiological Network) and (iii) potentially toxic phytoplankton species and their cell density (REPHY, phytoplankton Network).

The RNO network verifies that the concentrations of all heavy metals (particularly mercury, cadmium and lead) in mussels and oysters remain below the threshold levels (RNO also monitor heavy metal and organic molecule concentrations in sediments). The REMI measures the concentrations of coliforms, mainly *E. coli,* every month in the water and in the shellfish, however if coliform concentrations in the water start to increase, the monitoring frequency is enhanced to one sampling per week. The frequency is also dependent on the zone indices (A, B, C or D). The REPHY measures the increase in the major dinoflagellates (*Dynophisis, Alexandrium, Prorocentrum*) and the presence of toxins in the tissues once a month, and, more often if there is a bloom (Dosdat and Pomelie, 2000). Collectively the monitoring of shellfish production conducted by the network ensures the safety of the product for human consumption.

Greece

Context

Greece cultures 26 species of aquatic organisms (FAO, 2007) in fresh, brackish and seawater. Freshwater production is dominated by rainbow trout (*Oncorynchus mykiss*), with production of 2 446 tonnes in 2005. Aquaculture, however, is dominated by the production of three marine species; European seabass (*Dicentrarchus labrax*), gilthead seabream (*Sparus aurata*) and Mediterranean mussel (*Mytilus galloprovincialis*). Production of these three species was 30 836 tonnes, 43 588 tonnes and 26048 tonnes in 2005, respectively.

Legislative requirements

Along with many other countries Greece has translated the EU Directive on EIA into national legislation. In 1990 the Common Ministerial Decision 69269/5387/90 implemented the EIA procedures and 75308/5512/90, the rights to public participation. The former identifies the categories of works requiring EIA, which includes aquaculture development.

In addition there are a number of specific Administrative Directives (AD) within Greek legislation that concern particular ministries and procedures for aquaculture development. These are as follows:

93/259637/AD	Administrative Directive of Ministry of Agriculture (evaluation of environmental studies concerning the establishment of aquaculture farms)
94/258374/AD	Administrative Directive of Ministry of Agriculture (procedures concerning the establishment of aquaculture farms)
89/1089177/6325/0010/AD	Administrative Directive of Ministry of Finance (concerning the procedures related to the use of coastal areas supporting marine aquaculture farms)
93/500530/AD	Administrative Directive of Hellenic Tourism Organization (concerning parts of the procedures related to aquaculture farms’ establishment)
89/M3148/AD	Administrative Directive of Ministry of Mercantile Marine (concerning leasing procedures of seawater bodies for aquaculture farms’ establishment)

In Greece, licensing of marine aquaculture (both fish and shellfish) is perceived as complicated, time-consuming and bureaucratic (Papoutsoglou, 2000; Dickson *et al.*, 2005). There are a large number of statutory organizations and regulations involved in licensing of new aquaculture developments in coastal regions, despite the fact that in 2005 there appeared to be no specific coordinated aquaculture policy in Greece (Dickson *et al.*, 2005). License requirements cover environmental protection, secure navigation, shipping regulation, commercial fisheries protection, public health protection, archaeological site protection and tourist activities. Socio-economic conditions are also taken into account in terms of public perception, peace and environmental sensitivities, existing land or sea area use, visual impact and politically sensitive areas. With different ministries responsible for each of these elements, there is a need for aquaculture developers to gain approval from many authorities.

Finfish sea-based net-cage farms

The leasing and licensing procedure for the aquatic area starts with the submission of an application to the authorized service (branch of Ministry of Agriculture). The application has to include a map of the major marine and land area, a site chart, a preliminary feasibility study (brief technical and economical survey with basic information on the farm design, number, type and size of cages, species to be produced, expected production and outline of production plan). A description of the underwater topography of the site is also required, with a profile of the net-cages in relation to the water depth.

At the same time, an application has to be submitted to the Ministry for Environmental, Physical Planning and Public Works to obtain a pre-approved permission for the use of the site, which also has to include a topographical map and bathymetric chart of the specific site, photographs of the site, a feasibility study and a public questionnaire. In addition, to receive final operational permission for the farm, an environmental survey, which outlines any possible 'effects' of the farm, must be sent to the land use planning authority.

Finfish land-based on-growing farms (including hatcheries)

Applications for land-based aquaculture developments are submitted to the regional branch of the Ministry of Agriculture (Department of Fisheries and Aquaculture). The application should include a map of the major area and plans for the proposed buildings, a feasibility study with detailed information on the chosen fish species, total land area and water volume required, number, size and type of tanks or raceways to be used, supply system of sea or/and fresh water, construction works, transportation needs and financial management. An environmental survey of the area and approved waste disposal methods should also be provided.

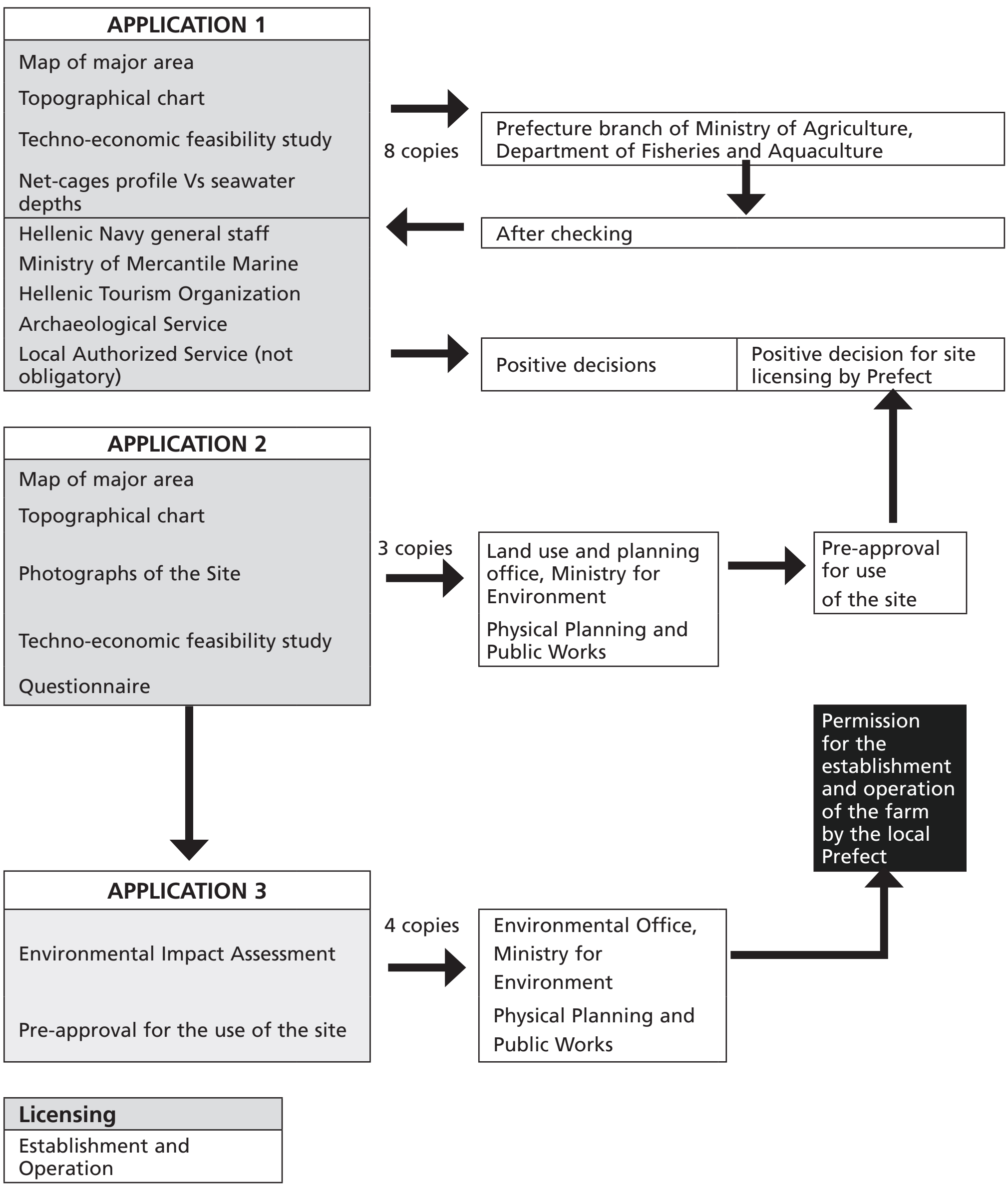
The environmental protection criteria for land-based farms come under the existing legislation. This requires an approved special waste disposal study and includes recommendations for the treatment of effluents before their discharge. However, the treatment procedure only includes mechanical filtration and sedimentation at farms with an annual production of up to 150 tonnes, and biological filtration and disinfection are only considered when annual production exceeds this limit (Papoutsoglou, 2000). Abstraction of water itself for aquaculture purposes also requires a permit, but is available for free on application from the relevant water authority (Klaoudatos, 2001).

EIA requirements

An EIA has to be submitted in order to lease the site and to be able to obtain permission for the operation of a finfish farm. The EIA is required to include production management details and a description of the specific area in terms of the physical, chemical and biological parameters of the waterbody. The procedure for submission of EIAs is given in Figure 4.

Seawater samples are analysed before and also during (monitoring) the operation of the fish farm, physical parameters include measures of temperature, salinity, turbidity

FIGURE 4
Licensing and leasing procedures for finfish net-cage farms in Greece (after Papoutsoglou, 2000)



and suspended solids and chemical parameters include measures of ionic composition, dissolved oxygen, nutrient concentration and dissolved and particulate organic matter (Klaoudatos, 2001). An EIS should also include: measurements of the physicochemical parameters of the marine environment, including suspended solids, wave height, the direction and speed of the wind, the direction and speed of the water currents, depth, substrate type of the sea bed and the structure of the macrobenthic community. Such measures of biological and chemical data are extensive but typical of fish farm development assessment in the Mediterranean (ECASA, 2007). They are readily measured using standard biological and chemical techniques.

There are specific regulations governing water quality in freshwater fish farms (in coastal lagoons and rivers). The EIS must make a statement on the impact of the culture practices on specific water quality parameter (shown below). Subsequent control of these physico-chemical parameters is necessary throughout the production process through careful monitoring (Morou, 1996; cited in Klaoudatos, 2001) and application of water quality limits below:

Dissolved oxygen	5–9 mg/l
Saturation level	50–100%
BOD5	3–6
Suspended solids	25
Ammonia	0.1 mg NH_3–N/l
Nitrites	0.1 mg NO_2–N/l
Nitrates	100 mg NO_3–N/l

Food quality standards are also imposed on the production of aquatic organisms in Greece, they comply with EU Directives and local laws and refer to:

- the formulation of artificial diets;
- storage of aquatic feeds;
- transport and storage of feedstuff and additives, sourced from both inside and outside the EU;
- quality control measures.

The complexity of the regulatory process and the number of organizations involved make aquaculture development in Greece a very cumbersome and bureaucratic process (Papoutsoglou, 2000). At present the process is far from ideal and requires a more widespread use of EIA within regulation and licensing. In the view of a stakeholder - "At a national level it is not unusual to have to apply for seven or more permits from different government departments and then to have to go to regional and local authorities to receive appropriate documentation to start [his] business" (Dickson *et al*., 2005).

In a study of non-aquaculture related EISs, Androulidakis and Karakassis (2006) suggested that in Greece much of the information included in an EIS (until recently) has been obtained from generalised published data rather than measurement of site specific environmental data. There is no evidence to confirm whether this applies to aquaculture development as described but if it is, this clearly leads to potential problems that can inhibit development of aquaculture. In particular generalised data from a local area must be treated with caution and site applications may be limited by the imposition of non-specific and unrealistic environmental controls, which might limit development. For good environmental control, it is imperative that site-specific information is gathered and presented for fish and mussel farm development.

Hungary

Context

There are 13 species of aquatic organisms cultured to varying degrees in Hungary, all grown in freshwater ponds or tanks. Farms using semi-static systems are often involved in national "Agricultural Environment Protection Programs". The farms involved in this programme represent 90% of the total fish pond area (CONSENSUS 2005a).

Production is dominated by common carp (*Cyprinus carpio*) with 9 739 tonnes harvested in 2005. However, this is a significant and constant decline in production from a peak in 1983 of 18 407 tonnes (FAO, 2007). The only species being cultured that shows increasing production is the African catfish (*Clarias gariepinus*). Catfish production remains relatively low but there has been a consistent increase in production to 1 412 tonnes in 2005 since the start of production in 2001 (FAO, 2003-2008 NASO Hungary).

Regulation

The main government agency involved in aquaculture and fisheries is the Game and Fisheries Department within the Ministry of Agriculture and Regional Development. The main task of the department is to provide overall administrative control of aquaculture and fisheries, to ensure an adequate legislative and economic framework. The department is also responsible for the maintenance of fish stocks in natural waters, the protection of their gene pools and the management of the Fisheries Fund, which is financed from state revenues (fees from fishing licenses and fines) (FAO, 2003-2008 NASO Hungary).

The New Fisheries Act has been in place since 1997, which provides the legal framework for the responsible use and protection of water resources. Fishing rights belong to the state, except for enclosed waters owned by private individuals. Fishing rights are granted by the state to various users such as fisheries cooperatives, municipalities, angling associations, state and private organizations and private persons. The main fisheries authority is the Game and Fisheries Division of the Ministry of Agriculture and Rural Development, which carries out its administrative work through 19 regional fisheries inspectors (one in each county) employed in regional agricultural offices. The licensing is a three-step procedure:

a. Submit documents that show land ownership, layout map, description of technology and facilities. Basic conditions for water supply and effluent disposal must be available to the Regional Water Authority, which gives the **preliminary** license for water use.
b. Various authorities must be approached to get a license for construction of the farm.
c. After the construction of the farm an official check-up survey is made and after consulting authorities the **final** license for water use can be received.

There has been a dynamic change in the fish production sector in Hungary following the social, economic and political changes in Eastern Europe during the early nineties which in Hungary resulted in the privatisation of aquaculture. However, during this transition, pond fish farms have deteriorated in terms of their physical structure and the facilities available, as well as in terms of environmental consideration.

The latest challenge for the sector has been during Hungary's accession to the European Union, though this has lead to the development of some specific objectives in relation to aquaculture and the environment, identified as part of a medium-term development strategy for aquaculture (FAO, 2003-2008 NASO Hungary). When Hungary became a member of the EU, the Financial Instrument for Fisheries Guidance (FIFG) became available for the modernisation of the aquaculture sector. FIFG is a community measure (Council Regulation No 1263/1999), with the main objective of setting policy priorities and establishing a framework that contributes towards a sustainable balance between fisheries resources and their exploitation. According to FIFG, measures for the modernisation of the Hungarian aquaculture sector have been outlined in the Hungarian Agricultural and Rural Development Operational Programme, which forms part of the National Development Plan. The main *environmental protection* recommendations from the FIFG for the Hungarian fish production sector are summarized (FAO, 2003-2008 NASO Hungary) as follows:

- Gain acceptance by the environmental authorities of the special nature of fish ponds, including the maintenance of aquatic habitats and biodiversity, which the state should support.
- The sector should receive reasonable compensation for the damages caused by protected birds.
- The role of the fishponds as potential biological water treatment units should be recognised and supported.
- The "Aquatic habitat sub-programme" should receive a more pronounced role in the "National Agricultural Environment Protection Programme".

However, despite these objectives being set and outlined for farmers under the Hungarian Agricultural and Rural Development Operational Programme, no specific monitoring requirements have been stipulated for aquaculture facilities.

In addition a fund has been provided by the Ministry of Agriculture and Rural Development in Hungary to develop a strategy for sustainable aquaculture development. The ministry also supports a project which aims to address best management practices for pond fish culture (CONSENSUS, 2005a).

Italy

Context

Italy has a very diverse aquaculture profile with some 46 species of aquatic organisms under cultivation (FAO, 2007) in fresh, brackish and marine waters. However, aquaculture is dominated by three main species (2005):

- Japanese carpet shell (*Ruditapes philippinarum*) – 65 387 tonnes/yr;
- Mediterranean mussel (*Mytilus galloprovincialis*) – 54 039 tonnes/yr;
- Rainbow trout (*Oncorhynchus mykiss*) – 30 558 tonnes/yr.

Italian aquaculture appears to be in a decline at present, after a peak of 245 000 tonnes in 1998 (Saroglia *et al.*, 2000). The increase in production of carpet shell has been considerable since its beginning in 1984, which however has lead to severe oxygen depletion in the clam farming lagoons in Italy (CONSENSUS, 2005c).

Regulation

The aquaculture industry in Italy is regulated (FAO, 2006-2008 NALO Italy) in terms of environmental protection under Law No. 152, which implements EEC Directive 91/271 and Directive 91/676 (European Commission 1991a; 1991b). This law aims at ensuring that all waterbodies can be designated as having "good" water quality status by the end of 2016, but being at least "sufficient" by 2008. Veterinary chemicals are regulated under Legislative Act no. 119 (1992), which implements EEC Directives 81/852, 87/20 and 90/676 (Panunzio and Iandoli, 1999; European Commission, 1990; 1987; 1981).

Aquaculture and fisheries within Italy are authorised by the Ministry of Agriculture and Forest Policies, Directorate-General for Fisheries and Aquaculture. In addition, concessions for the establishing of aquaculture facilities are the responsibility of the Ministry of Infrastructure and Transport, in particular via the Directorate-General for Maritime and Inland Navigation Infrastructures, operating within the Department of Navigation and Maritime Transport.

Regulation of agriculture (including aquaculture and fisheries) was initiated in 2001 under Law No.57 and Law No.154 of 2003. This Law on the "Modernization of the Fishery and Aquaculture Sector" established a "Blue Table" group, which is coordinated by the Minister of Agriculture and Forest Policies and includes regional councillors for fisheries and aquaculture and representatives from stakeholder groups and representative of the Ministry of Environment and Land Protection.

The current national fisheries and aquaculture policy is established as a series of three-year plans that are revised every year. These plans emphasize the importance and diversification of aquaculture in Italy, within EU guidelines under three priorities:

- site identification in terms of maximising productivity while minimising environmental impact;
- product quality and certification;
- positive environmental effects (i.e. use of vallicultura for conservation of wetlands).

The Italian Fish Farming Association (API) purports to have adopted a Code of Good Farming Practice. As a member of FEAP, it is presumed that the Italian code is consistent with the FEAP Code of Conduct for European Aquaculture (FEAP, 2000) and in turn with the FAO Code of Conduct for Responsible Fisheries (FAO, 1995).

Environmental requirements

Under the aquaculture regulations an application for an aquaculture development requires information to be submitted to the chief of the competent Maritime Compartment (Ministry), containing a technical report on the construction, a map of the required concession area, construction plans and certification of rights claimed by the applicant.

There is no systematic national legislative framework for Environmental Impact Assessment in Italy in relation to EU Directive 337/1985 (FAO, 2006-2008 NALO Italy). However, by establishing guidelines for the regulation of EIA procedures by Regional Authorities through the legislation below, the Directive has essentially been implemented for aquaculture development.

- DPCM (Prime Minister Decree) 337/88 lists projects to be subjected to the national EIA. The list reproduces the Annex I of the EIA Directive.
- DPCM on December 1988 set up technical requirements to draw up the environmental study.
- DPR (Presidential Decree) on February 1998 adds projects to the list of the DPCM 337/88.
- DPR (Presidential Decree) on September 1999 number 348 regulates technical requirements of the environmental impact assessment for some activities.
  - (i) 1089 of 1 June 1939 "Protection of artistical and historical sites";
  - (ii) 1497 of 29 June 1939 "Protection of the natural beauties";
  - (iii) 431 of 8 August 1985 "Urgent regulation for the protection of environmental interest areas";
  - (iv) 349 of July 1986 "Ministry of Environment".

Under this regulation an EIA is compulsory for aquaculture developments of over 5 ha in size if it is to be established within a protected area. Developments outside of protected areas are subject to a screening of opinion as to the need for an Environmental Impact Assessment and production of an Environmental Impact Statement (EIS).

Where an EIA is deemed to be required, the EIS should provide:

- a project description;
- potential effects on the environment;
- environmental and land-use provisions;
- mitigation and repair measures.

This applies some of the criteria within the defined EIA guidelines (see Annex 1) given in the EU EIA Directive 97/11/EC. In addition, if the application involves conservation or areas with special protection laws a "*nulla osta*" is needed (Panunzio and Iandoli, 1999) that requires an assessment from the public body entrusted with the protection of that area, which may involve, up to 30 to 40 other stakeholders. In such cases applications can take several years for both completion and the granting of a license to produce fish. Once a license for an aquaculture development has been granted a further permit is required that gives permission to discharge water from the fish farm and (if applicable) to abstract waters from freshwater systems. Depending on what is actually required there can be anything from one to several public bodies that must grant permission. The primary authority is the Ministry of Public Works. Again, if the development is complicated this procedure may take years rather than months. Overall it is demonstrated that the application procedures are often a complex and highly bureaucratic procedure (after Panunzio and Iandoli, 1999).

The environmental laws based around EU Directives 91/271 and 91/676 are to ensure sustainable waters by 2016 by applying certain standards of quality. In terms of coastal waters, water quality must be monitored seasonally for most of the year, except between June and September when they are monitored bi-weekly. Parameters measured include: temperature, pH, salinity, transparency, orthophosphate, total phosphorus, entero-bacteria, dissolved oxygen, chlorophyll a, total nitrogen, ammonia, nitrate and nitrite. Biological parameters must be measured twice per year, and "ground" parameters in culture areas are measured once per year. A trophic index is applied using data collected from these measurements:

$$Trophic\ Index = \frac{[Log_{10}(Chl\ a \times DO \times N \times P) + 1.5]}{1.2} \quad (1)$$

Waters are then classified by the value of their trophic index as in Table 3.

TABLE 3
Classification of coastal waters under the Trophic Index in Italy (Saroglia *et al.*, 2000)

Trophic Index	Condition	Characteristics
2–4	Very good	Good transparency, absence of abnormal water colouring, absence of hypo-oxygenation of sediments
4–5	Good	Occasional water turbidity, occasional hypoxia of benthic waters
5–6	Mediocre	Slight transparency of waters, abnormal water colouring, hypoxia and occasional anoxia of sediments, benthic ecosystem distress
6–8	Poor	High turbidity, persistent abnormal water colour, persistent hypoxia/ anoxia in sediments, death of benthic fauna, benthic community modification, economic damage to tourism, fishery and aquaculture

Regulations for veterinary medicines in Italy are based on EU Directives 81/851 and 90/676 (European Commission, 1990; 1981). The law forbids the use and possession of pharmacologically active substances and requires that therapeutic treatments are carried out under the direction of a professional veterinarian, under prescription. Use of therapeutants must be recorded and reported to the local health authority. The Ministry of Health can allow the use of new toxic therapeutants for which an EU Maximum Residue Level (MRL) can be determined, or non-toxic ones without the requirement for an MRL.

The general perception is that the highly bureaucratic nature of the system in Italy is a significant impediment to the development of aquaculture. It is unclear how the implementation of the more recent EU Directives will clarify the issues and system of application.

Netherlands

Context

Aquaculture in the Netherlands is limited to a few species and dominated by the mussel, *Mytilus* sp. (59 500 tonnes in 2005; FAO, 2007). There has been a general decrease in culture of mussel over the past 15 years since production peaked at 1 302 712 tonnes in 1982. The culture of European eel and African catfish began in the Netherlands in the early 1990's and both had a combined annual production of approximately 4 000 tonnes in 2005.

Shellfish culture in the Netherlands is a traditional industry but there have been no new licenses for production issued for bottom culture since the 1960's. Since 1987 several licenses have been issued for rope culture in the Oosterschelde estuary, but all prospective coastal sites are now exploited and no new shellfish culture is permitted. The potential for aquaculture expansion is therefore limited to inland freshwater systems.

There is no system in Dutch law specifically for authorisation of inland aquaculture. Each new farm requires a number of permits by various ministries mainly dealing with environmental protection and land-use planning regulations. In general terms, under the Environmental Protection Act (1993, as amended) developments involving the cultivation of animals, including fish and shellfish, require an EIA which conforms to EU Directive 85/337/EC, amended 97/11/EC (see Annex 1). However, at present there is no specific EIA requirement for aquaculture farms in Dutch law (FAO, 2006-2008 NALO Netherlands).

Regulation for shellfish culture

In the Netherlands the overall responsibility for the development and management of the aquaculture sector, rests with the Ministry of Agriculture, Nature and Food Quality. As part of the EU regulation for shellfish quality a monitoring programme is carried out by the Netherlands Institute for Fishery Research (RIVO), under contract of the Fisheries Department of the Ministry, together with the Dutch Fish Board. Monitoring of live shellfish processing is carried out by the processing companies.

Monitoring of pathogenic bacteria is done on a bi-weekly basis in several areas of the Oosterschelde, the Wadden Sea and Lake Grevelingen. If the fishery for cockles or *Spisula* spp. is extended to other areas, then the monitoring programme will also be extended. If samples are shown to exceed the standard, the area is closed for harvesting and sampling is repeated. If the subsequent samples show that limits are not exceeded, then the area will be reopened. In practice the standards are met in almost all cases, as discharge into shellfish culture areas is prevented as part of the Dutch water management (Smaal and Lucas, 2000).

The National Department for Control of Meat and Live Stock, part of the Ministry of Agriculture, Nature Conservation and Fisheries and the Dutch Fish Board are responsible for the control of water quality in shellfish culture areas, as well as handling and processing. The monitoring of biotoxins is carried out at stations along the Dutch coast where wild shellfish fisheries are located. Water samples are tested for contaminants and microorganisms and shellfish meat is tested for diarrheic shellfish poisoning (DSP), paralytic shellfish poisoning (PSP), amnesic shellfish poisoning (ASP) and neurotoxic shellfish poisoning (NSP). Contaminant concentrations in (wild) mussels are also monitored on a regular basis as part of water quality control programmes, though in practice contaminant levels rarely exceed EU quality standards for shellfish.

One of the requirements concerning shellfish production is to ensure that there is an underlying quantity of shellfish available in order to satisfy natural bird feeding needs. In order to determine whether there is a requirement to reserve food for shellfish-eating birds, annual stock assessments of mussel spat (and also of cockles and *Spisula*) are carried out by the RIVO, under contract of the Fisheries Department of the Ministry. This work is also partly funded by the producer organizations. Intertidal mussel stocks are monitored by aerial photography, along with ground observation. Subtidal mussel spat stocks are monitored prior to fishing activities in spring and autumn, for which an extensive network of monitoring stations are used. Oyster stocks are not part of a regular monitoring programme, but surveys are carried out occasionally (Smaal and Lucas, 2000).

These monitoring programmes result in the assessment of the stock prior to the fishing activity of that year and are the basis for fishery licenses. Data from the stock assessments is used to evaluate the carrying capacity of an area, in terms of the amount of food available and the stock size of other non-commercial filter feeders. In addition, the quality of the shellfish waters is designated under the EU Directive 79/923/EEC and may require protection or improvement for the production of shellfish. These waters are carefully monitored in this regard.

Wastes from broken shell, undersized mussels and mussels from the packaging, purification and processing plants in Yerseke, Netherlands, are taken by ship and dumped in regulated areas at sea (CONSENSUS, 2005c).

Poland

Context

Aquaculture in Poland is based on freshwater culture and dominated by production of the common carp and rainbow trout, with 18 600 tonnes and 15 700 tonnes produced in 2005, respectively (FAO, 2007). Over the last ten years the production of these two species has switched in emphasis. Production of carp peaked in 1992 at 25 000 tonnes and is now in decline. Trout production has increased year on year from 4 991 tonnes produced in 1995. Carp farms operate either an extensive or semi-intensive culture, which use natural resources to feed their fish, without addition or only small addition of food. Trout farms in Poland are fitted with modern, effective systems for treating water and hence are deemed to have little or no impact.

Legislative context and EIA

Strategy development for aquaculture and fisheries in Poland is within the remit of the Ministry of Agriculture and Rural Development (MARD). Within this Ministry, the Department of Fisheries is responsible for the development of marine fisheries, inland fisheries, aquaculture and marketing of fish products.

General legislation on EIA in Poland has its root in the early 1990's and significant implementation of requirements since then (see Woloszyn, 2000, for a review), after transition and accession to the EU. The principal legislation covering EIA requirements is as follows:

1. The Environmental Protection Law of 27 April 2001 (Dz. U. 2001 No 62, item 627);
2. The Regulation of the Council of Ministers of 24 September 2002 on the categories of projects that may have significant environmental impact and on the criteria of screening projects for environmental assessment (Dz. U. 2002 No 179, item 1490).

Within the above frameworks the categories defined in the Regulation of Council of Ministers (point 2 above) are particularly important as this Regulation identifies certain aquaculture development as a Group 2 activity. Group 2 activities are defined as "might require an EIA" (Jendroska *et al*., 2003). The specific requirement for consideration of an EIA process is laid out as follows:

> "*Rearing of fish in fish ponds, where the production is over 4 tonnes of fish per 1 ha of a pond surface (for carp and similar fish), and rearing of trout, where the production is 1 tonne of fish with water consumption of 1 l/s*" (Jendroska *et al*., 2003).

Many fish ponds in Poland are large, ranging between a few hectares to some 1 700 hectares (FAO, 2006-2008 NASO Poland). However, as the majority of the production is of an extensive nature the production per hectare tends to be low ranging from 2 to 300kg (Polak *et al*., 2008). There is therefore uncertainty about whether pond culture in Poland has ever specifically undergone an EIA procedure. More generally, inland pond culture is also seen to have positive benefits on biodiversity (Ciesla *et al*., 2008), whilst at the same time is perceived to have limited adverse effects on the environment.

Farmers with salmonid aquaculture or any other fish culture with a pond surface area larger than 10 ha are obliged to provide an environmental impact assessment plan, thought it was not possible to determine examples of this occurring. Whilst there is little or no available information concerning specific EIAs it is possible to infer that the EIA requirements have not specifically been invoked for aquaculture development in Poland since the EIA regulatory requirements have been in place in Polish legislation. In addition, there is no aquaculture law concerning water use (Ackefors, 2000) and pond and raceway farmers of carps and trout are free to remove water for aquaculture purposes. Within this context there are certain maximum loads that are not allowed to be exceeded (Ackefors, 2000), namely:

Parameter	Limit
Suspended solids (SS)	< 20 mg/l
Biological Oxygen Demand (BOD)	<4.0 mg O_2/l
Chemical Oxygen Demand (COD)	25.0 mg O_2/l
Phosphate (PO_4 – P)	< 0.065 mg/l
Nitrate ($N0_3$– N)	< 1.129 mg/l

It is clear from Woloszyn (2004) that the concept of EIA in Poland remains in its infancy and that little or no EIA processes have been undertaken for aquaculture development. This may have been compounded by the fact that financial support available to Polish scientific and research priorities has been modest and thus only a relatively small amount of scientific research can be applied directly to aquaculture (FAO, 2006-2008 NASO Poland). Importantly, accession to EU membership comes with access to European Fisheries Funds (EFF) and Financial Instrument for Fisheries Guidance (FIFG). Polish authorities have now developed a National Strategy for the Development of Fisheries in Poland (2007–2013), which includes the following priorities:

- to increase the profitability of the sector as a whole;
- to reduce the environmental impact of fisheries and promote environmentally friendly technologies;
- to develop aquaculture and inland fisheries;
- to improve the quality of fish products, including guaranteeing food safety for consumers;
- to develop scientific thought and new technologies.

Within this context, the elements above that concern aquaculture may include some element of environmental impact studies and assessment methods. It is believed that the success of the Polish aquaculture industry can be ensured by co-ordinating the activities of fish producers, the state administration and organizations responsible for environmental protection.

Spain

Context

Spain is the most diverse producer of cultured aquatic organisms in the EU, commercially producing 66 species since the 1980s, with 35 species still being cultured in 2005 (FAO, 2007). However, only three species are produced in significant quantities (>10 000 tonnes per annum) and of these production is overwhelmingly dominated by blue mussel culture (*Mytilus galloprovincialis*) – producing 158 059 tonnes in 2005 with a peak of 262 000 tonnes in 1999. The largest fish production is the freshwater culture of rainbow trout with 25 959 tonnes in 2005. Within the marine environment turbot, seabream and seabass are the most important fish species, totalling 23 556 tonnes of production in 2005.

Regulation

The principal authorities for aquaculture development in Spain are the ministries for agriculture, fishing, the environment and public works and transport. Regulation of aquaculture comes under federal and state laws. There are two federal laws; Law of Marine Farming (Law 23/1984) and Law of Coastal Zones (Law 22/1988). These cover the regulation of aquaculture in rivers, lakes, coastal and land-based systems, and safeguard the public use of coasts and jurisdictional waters (EEZs). EU Directive

85/337/EC, amended in 97/11/EC, has been integrated based on Royal Legislative Decrees 1302/1986 and 1131/1988 as well as Law No. 6/2001 (FAO, 2006-2008 NALO Spain). In addition, all 17 autonomous regions in Spain regulate applications for aquaculture installations by requiring (Basurco and Larrazabal, 1999; Pinchetti, 2008) the following:

- A physicochemical and biological study of the area and surroundings, including: site location studies for new installations, hydrographic survey, evaluation of depuration systems, required water resources (closed systems) and effluent depuration and dumping control to avoid modifications to the original substrate conditions. Also, appropriate controls on the amount and use of chemicals (cleaning of installations and animal treatment) and feed must be investigated.
- Biological measures should include: the appropriate control of predators, control of chemicals and other substances and monitoring of disease. Studies on the natural distribution of species and carrying capacity of natural populations must also be investigated.
- A socio-economic study, including alternative uses of old installations; any social impacts the project may have and any potential impacts on the fishing sector.
- A technical study, including an adequate choice of locations to avoid landscape modifications and excessive noise; construction plans and maps of where the installation is to take place, as well as a financial account of the total budget needed for the development.
- A photographic study of the area, giving alternative locations for the aquaculture development.
- A study of the environmental impact; variables to be measured include:
  Water: pH, temperature, suspended organic/inorganic matter, colour, salinity, dissolved oxygen, hydrocarbons, organohalogen substances, metals (Ag, Ar, Cd, Cr, Cu, Hg, Ni, Pb, Zn; mg L^{-1}), nitrogen, phosphorus, chlorine, bromide, methane and sulphur compounds and faecal coliforms.
  Sediment: grain-size, organic matter and levels of polluting agents (heavy metals, hydrocarbons and chemicals).
  Biological variables: detection of micro-organisms (sulphobacteria and coliforms by microscopic observation of selective cultures and specific biochemical tests), monitoring of plankton, nekton and benthos.

Applications are approved by a number of authorities, specifically in order of importance; 1) regional councils, 2) local councils, 3) navigation authorities, 4) National Fisheries General Directorate, 5) Ministry of the Environment. Other organizations also include the regional Tourism Office, Service of Public Health and Fishermen Associations. In addition, each autonomous area applies their complementary regulations. It normally takes between one and two years to obtain a permit through this application procedure, but this can vary with region. Licenses are granted for up to ten years and renewed from between 10 and 50 years.

Land-based farms in Spain must have an administrative concession for the use of water. Each river basin has a hydrological plan and the law on water requires that when granting a concession for water usage, fish farms are placed in fifth position after water is supplied to populations, agriculture, hydroelectric energy production and other industrial uses. An impact study is required for the installation of a land-based farm through the government decree of 28 June 1986 pursuant to European Directive 85/337/CEE. An impact study must be submitted when the farm application undergoes public consultation. The concession for water use is granted by the organization that manages the river basin and the applicant has to pay a royalty for the use of water (Petit, 1999). The proposed approach corresponds to the general mode at the national level but it should be noted that there is also legislation at a regional level and hence each region has its own legislative power (CONSENSUS, 2005b).

Environmental standards for water and sediment quality conform to EU Directives, they include quality control of waters for shellfish farming (EC 79/923/CE) and technical and sanitary control over shellfish and finfish production (EC 91/492/CE) modified by Spanish Royal Decree 571/1999. In Galicia (Sanchez-Mata and Mora, 2000), these are applied by research centres managed by the regional government:

- Red Tide Control Centre – study of algal blooms and nutrient flux;
- Marine Research Centre – providing favourable environmental conditions for exploitation of marine resources;
- Marine Farming Centre – marine shellfish reproduction for repopulation of marine farming areas;
- Marine Aquaculture Research Centre – research on bivalve reproduction, larval development and broodstock viability and production of live feeds for marine fish larval production.

Classification and control of veterinary medicines and their residues are carefully regulated in Spain. The use of chemotherapeutants not referred to in ordinance 2377/90/EEC has been forbidden. Listed chemicals include antibacterial substances, medicines (anti-helminthics) and environmental contaminants: organochlorinated compounds (including polychlorinated biphenyls – PCBs), chemicals, mycotoxins and colorants. The residue levels for chemicals used in aquaculture are centrally defined, see Cacho (1999) and are encompassed in a National Plan for Residual Research in Aquaculture, for finfish and other aquaculture products.

Turkey

Context

Aquaculture has a relatively short history in Turkey and began with the farming of rainbow trout (*Onchorhynchus mykiss*) and common carp (*Cyprinus carpio*) in the late 1960s. It developed further with gilthead seabream (*Sparus aurata*) and European seabass (*Dicentrarchus labrax*) culture in the mid 1980s. Production of the three major species, namely rainbow trout, seabass and seabream increased rapidly during the 1990s. Production of rainbow trout, seabass, seabream, mussel and common carp had reached 80 000 tonnes per year by 2003, stemming from 1 659 farms (FAO, 2006-2008 NASO Turkey).

Legal framework

The institutional framework for aquaculture development is well established under the Ministry of Agriculture and Rural Affairs (MARA), the Fisheries Law, Article 13, first paragraph states: "Those who wish to set up/own aquaculture production facilities have to get permission from the Ministry of Agriculture and Rural Affairs (MARA)". MARA is responsible for the administration, regulation, protection, promotion and technical assistance of fisheries and aquaculture through four general directorates: the General Directorate of Agricultural Production and Development (GDAPD), the General Directorate of Agricultural Research (GDAR), the General Directorate of Protection and Control (GDPC) and the General Directorate of Organization and Support (GDOS).

The GDAPD is the responsible authority for development and management of aquaculture. The GD includes an Aquaculture Department consisting of three divisions; marine aquaculture, inland aquaculture and aquaculture economics and marketing its main responsibilities are (Okumus, 2007):

- producing and promoting policies for development of aquaculture;
- designating sites, area and zone for aquaculture;
- administering rental procedures for the sites;
- administering licensing process and issuing fish farming licenses;

- preparing and implementing projects;
- controlling and monitoring fish farms;
- providing technical and financial support.

GDAR is responsible for research and GDPC for movements of live fish, diseases and fish as food issues. MARA has provincial directorates in 81 provinces responsible for implementing policies issued by its central office in Ankara. Most of the licensing and monitoring and control activities are carried out by these provincial directorates. A number of public institutions are also involved in the licensing process of aquaculture sites including; the Ministry of Environment and Forestry, the Ministry of Culture and Tourism, the Navigation and Oceanography Department, the Under-Secretariat of Maritime Issues and the General Directorate of State Hydraulic Works (DSI).

Aquaculture is regulated through licensing, health and environmental regulations. The primary law concerned with the regulation of aquaculture is the Fisheries Law Act No. 1380 of 1971, amended by the Fisheries Law No. 3288 of 1986. More recently the Aquaculture Regulation No. 25507 of 24 June 2004 came into force, which addresses major issues related to the sector; specific issues are regulated through ministerial decrees (FAO, 2006-2008 NASO Turkey).

The regulation covers and sets out rules for the following issues (Okumus, 2007):

- site selection for inland and marine farms;
- application and evaluation procedures for fish farming licenses;
- approving the projects and issuing licenses;
- improving production capacity, species etc, cancellation (closing down farms), site changes and sales;
- other aquaculture activities (tuna fattening, organic farming, integrated production systems);
- importing brood fish, egg and fry;
- compulsory technical staff employment;
- fish health management;
- environmental impacts and protection;
- monitoring and control of farming activities.

Before aquaculture licenses are issued all projects are evaluated taking into account national economic development plans, general health issues, transport logistics and a number of technical and scientific factors. Despite recent revisions and efforts at simplifying the licensing procedure it is still quite complex and time consuming and currently most fish farming licenses are issued by the provincial directorates of MARA. According to the Environmental Impact Assessment Regulation (EIA) No. 25318 of 16 December 2003, those farms with an annual capacity of less than 30 tonnes do not require an EIA, farms with a capacity of between 30 and 1 000 tonnes per year only require to submit a preliminary EIA, while aquaculture projects with an annual production capacity of greater than 1 000 tonnes are required to prepare an EIA report (FAO, 2006-2008 NASO Turkey).

Applicants are required to submit their applications either to Central Office (of the MARA Aquaculture Department) or Provincial Directorates of MARA. These applications are submitted with all the relevant supporting documentation, including species, capacity, production system and a map of the area (1/25000 scale). Applications for trout, carp, seabass and seabream on-growing farms and hatcheries for these species (up to two million fry/year capacity) can be submitted to the Provincial Directorates, whilst applicants for other on-growing species (namely turbot, sturgeon, eel, algae, molluscs and crustacean species) and trout, carp and seabass/seabream hatcheries with an annual capacity of more than two million have to apply directly to the Aquaculture Department in Ankara (Okumus, 2007).

A team of experts from the central or provincial office then visits the site and prepares a preliminary survey report. If the report is positive, a preliminary license is issued for 8 months and can be extended up to 12 months. Supporting documentation submitted for the preliminary licence must include an application letter, site map (1/25000 scale), the preliminary survey report and a water quality report.

The applicant can then prepare the full project documentation, which includes a farm or hatchery design and feasibility report and an EIA report. Standard applications must include: environmental management data, feed type and method, type of aquaculture, size and number of cages or tanks, sketches of onshore buildings, location, proposed stocking density, species, volume and type of discharge, volume of chemicals to be used and method of application and the maximum production tonnage. Any plans for fallowing or rotation of cage sites should also be presented (Deniz, 2001).

Approval is also needed from other related institutions dependent on the nature of the project (e.g., Ministry of Environment and Forestry, Ministry of Health, Maritime Affairs, Department of Transport, Ministry of Culture and Tourism and local government). If the project is approved the license (Fish Farming Certificate) is issued. This usually takes one year or more. The rental contract period for marine cages sites is for a maximum 15 years although the contract can be terminated earlier by the government (Okumus, 2007).

Important decision criteria for applications include (Deniz, 2001):

i the degree of enclosure of the waterbody;
ii the presence of protected species/habitats;
iii the number of other aquaculture ventures in the area;
iv the carrying capacity of the environment;
v the type of proposal.

Site selection

Initially a cage-farm site is chosen by assessing the legal requirements, site access, shelter and presence of other cage farms. However where available, allocated areas for aquaculture are preferred. According to aquaculture regulations the following requirements should be met (Okumus, 2007):

- The area should be large enough for rotation and should be no less than twice the actual area occupied by the cages.
- The distance between cage farms is determined by the central Aquaculture Department according to the following criteria; projected annual production capacity, water depth and current speed. Distance between tuna cage farms, and tuna and other fish farms cannot be less than 2 km and no less than 1 km between other fish farms.
- The minimum annual production capacities of farms are set up by the Aquaculture Department; currently the minimum capacity for a cage farm is 250 tonnes per year.
- Offshore, on the open coast and outside enclosed bays and gulfs, cage sites should have minimum 40m water depth. However, the Aquaculture Department may allocate sites for cage farming in less than 40m when taking into account the capacity of the farm, water depth, current speed and the intended production system.

Shellfish aquaculture should be at least 1 km from tourist hotels and secondary housing development to reduce the risk of disease and faecal contamination. Cage aquaculture, hatchery and tank farms should be at least 1 km from tourist centres. In scenic areas, distances of 0.5 km, 0.75 km and 1 km respectively, should be adopted. These distances are dependent on topography, concealment and screening. Hatcheries, ponds and tank farms should be screened from view with trees and shrubs. Cage and raft culture is restricted in heavily used recreational waters, but is permitted in waters with irregular traffic, this requires liaison between GDAIPD and the Navigation and Oceanic Directorate. Fish farms are encouraged to mark their boundaries clearly, all installations should have marker lights and tourists are not permitted in these areas (Deniz, 2001).

In 2006, the Ministry of Environment and Forestry amended the Environmental Law to exclude marine cages from environmentally sensitive areas, enclosed bays and near shore areas. Unfortunately the amendment to the law was prepared without any consultation with stakeholders and the definitions in the bill are considered somewhat vague. In addition the duration given to farmers to move to new sites out-with these areas was very short and unrealistic, thus the producers have taken the case to the Supreme Court. The Supreme Court has suspended the enforcement of the amended law, but operates according to the following environmental decree (Okumus, 2007):

- Parameters for sensitive areas where cage fish farms are prohibited:

Parameters	Criteria
Water depth	≤ 30m
Distance from coastline	≤0.6 mile
Current speed	≤ 0.1 m/s

- Fish farms can not be established in special protected areas or archaeological areas; large areas of the western Mediterranean and Aegean are enclosed within national parks or have special protected area status.
- Those fish farms outside the sensitive areas must be assessed according to the TRIX Index (TI) and reported to the Ministry of Environment:

TRIX Index (TI)	Explanation
TI < 4	No eutrophication risk
4 ≤ TI ≤ 6	High eutrophication risk
TI > 6	Already eutrophic

Licences granted by MARA are reviewed every two years. MARA scientists monitor conditions at representative aquaculture sites, before, during and after implementing the project. At least every two years near large farms. The data are then used to review and if necessary, alter the licensed production capacity. Licences are not automatically renewed without environmental data and can be withdrawn if the environmental quality standards are exceeded. A system of punitive measures for transgression of license conditions in order of severity may be implemented as follows: (i) monetary fine; (ii) withdrawal of licence; and (iii) withdrawal of licence and fine (Deniz, 2001).

Integrated coastal zone management

The lack of coastal zone management plans and subsequent site allocation leading to conflicts of interest and competition between the tourism and aquaculture sectors is one of the major constraints in the development of marine aquaculture. The Government of Turkey has gone to great effort since 2000 to resolve these conflicts. Site and area allocation plans have been prepared along the Mediterranean and Aegean coasts involving various stakeholders with some areas identified as immediately or potentially available for aquaculture development. Most of the marine farms have already left the well protected, near shore shallow waters and moved to relatively exposed offshore areas. In addition many farms now use the larger modern high density polyethylene (HDPE) circular cages (10–24 m in diameter) rather than the smaller locally made wooden cages.

Consumer expectations on fish quality, environmental and animal welfare issues and all year round product availability are increasing and intensification is causing serious outbreaks of disease and parasites leading to the use of antibiotics and other chemicals. MARA is attempting to effectively monitor all fish farms for diseases and to test for antibiotic/chemical residues in market size fish. Thus, stricter environmental monitoring will commence in the near future (FAO, 2006-2008 NASO Turkey).

Recently the Aquaculture Producer's Association (also a member of the FEAP) has been founded and has begun to provide valuable assistance towards aquaculture development. The current rate of development of the Turkish aquaculture sector is expected to continue, however poor product diversity, resource use conflicts, water availability and increasing environmental and animal welfare issues will be limiting factors (FAO, 2006-2008 NASO Turkey).

United Kingdom

Context

Aquaculture production in the United Kingdom is dominated by the culture of Atlantic salmon (*Salmo salar*) in Scotland. EIA regulation and monitoring for Atlantic salmon specifically is covered by Wilson *et al.* (this volume). Feeding this industry, however, is a relatively large cultivation of salmon smolts in freshwaters, through a combination of cage culture (relatively unique to Scotland) and through production in raceways. Smolt production is not typically measured in production (tonnes) but in smolts produced for on growing in sea cages. In 2006 production of smolts was 41.1 million. Other species produced in marine systems include cod, halibut and sea trout, which between them accounted for 543, 233 and 267 tonnes respectively in 2006 (CEFAS, 2008). In addition, production of rainbow trout in England and Wales totalled 4 866 tonnes in 2006 and 6 628 tonnes in Scotland. Arctic Char was also produced in small quantities (3.5 tonnes). Significant amounts of mussels (*Mytilus* sp.) and oysters (*Crassostrea gigas*) are also cultured, typically on long-lines and in intertidal bag culture respectively. In 2006 production of mussels was 4 219 tonnes and of oysters was 251 tonnes in Scotland; 3 181 tonnes and 680 tonnes respectively in England; 10 157 tonnes and 12.5 tonnes respectively in Wales and 10 000 tonnes and 346 tonnes respectively in Northern Ireland (CEFAS, 2007)

Management of aquaculture

Within the UK, the sovereign powers devolved to the regional governments in Scotland and Northern Ireland result in specific powers concerning the regulation and control of aquaculture development. England and Wales are considered together under common legislation, despite devolvement of specific powers to the Welsh Assembly. Although the legislative controls may operate differently between countries, in general terms the requirements for EIA as part of the application process (EU Directives, as applied into UK laws) and the provision of monitoring requirements, for example through permitted consent to discharge and more recently the EU Water Framework Directive, are generally similar between countries.

Throughout the UK the organizations responsible for aquaculture are the Department for Environment, Food and Rural Affairs (DEFRA), the Department of Agriculture and Rural Development for Northern Ireland (DARD) and the Department for Environment, Planning and Countryside (DEPC, Wales). In addition, there are two executive agencies responsible for scientific research and giving advice on aquaculture development; including the Fishery Research Services (FRS) in Scotland and the Centre for Environment Fisheries and Aquaculture Science (CEFAS) in England, Wales and Northern Ireland. In addition, the Seafish Industry Authority (SEAFISH) has no direct regulatory role but is a key public authority in management and promotion of aquaculture development, working across all sectors of the seafood production sector for the promotion of high quality, sustainable seafood.

Legislative framework for EIA and aquaculture

As a member of the EU the UK is required to implement EU Directives within their own legislation. The responsibility for this task lies with DEFRA (England and Wales), DARD (Northern Ireland) and SEERAD (Scotland). In the UK Environmental Impact Assessment (EIA) is an integral part of the process of determining most applications for marine fish farms, though not necessarily all others forms of aquaculture development. The EU Directive on Environmental Assessment (85/337/EC) as amended by Directive 97/11/EC seek to ensure that where a marine aquaculture development is likely to have significant effects on the environment the potential effects are systematically addressed in a formal Environmental Impact Statement (EIS).

The Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999 brought the amended EU Directive into force and superseded the Environmental Assessment (Salmon Farming in Marine Waters) Regulations 1988 with effect from March 1999. As the title suggests EIA now applies to all marine fish farm developments (including halibut, cod), provided they are above the trigger points for its enactment; i.e. being greater than 100 tonnes biomass or covering an area of 0.1 ha or more. It is not inevitable that an EIA will be required when the development is above these values, but the process of scoping (determination by the competent and statutory authorities) is enacted at these trigger points. Below these critical values EIA may still be required, depending for example, on the perceived environmental impact, which may vary with local water conditions.

There is currently no requirement for shellfish farm applications to undergo an EIA. Instead applications for shellfish farms are assessed only through public and statutory consultation, on submission of an application. Water quality for shellfish culture is governed under EU Directive 79/923/EEC, which requires areas to be of a suitable quality or to be improved for culture of shellfish. In Scotland, the directive has been implemented as the Surface Waters (Shellfish) Classification (Scotland) Regulations (1997). This Act establishes a classification of waterbodies where SEPA, the regulatory authority, has an obligation to implement suitable monitoring criteria to classify and ensure that waters are of suitable quality for culture. The onus is not on the aquaculture developer, who is not required to monitor their site.

Under the Registration of Fish Farming and Shellfish Farming Businesses Order (1985) and amended as Registration of Fish Farming and Shellfish Farming Businesses Amendment (Scotland) Order (2002), all aquaculture companies must register within two weeks of site operation.. The register is kept by FRS in Scotland, DEFRA in England and Wales and DARD in Northern Ireland. It records all movement of cultured organisms, to prevent spread of disease and introduction of unwanted species.

More generally the application of the EIA process in the UK is coordinated through Local Planning Authorities and to aid this process the EIA requirements are translated into a Planning Advice Note (PAN) No 58, which therefore plays a role in aquaculture development specifically.

Legislative framework for consent in aquaculture

The legislation concerning aquaculture development in Scotland is a two-fold process, with an application for siting (as outlined above) and following this, an application for consent to discharge (waste) for both marine and freshwater culture. Initially under the Control of Pollution Act (COPA) 1974, aquaculture development in Scotland now comes under the auspices of the EU Water Framework Directive as The Water Environment (Controlled Activities) (Scotland) Regulations 2005. Applicants are required to gain a Controlled Activities Regulation (CAR) license from SEPA, which permits feed, faecal and dissolved wastes generated by fish to be discharged to the environment. Each license issued is farm specific and lays down the maximal biomass (marine) or production (freshwater) allowed, the infrastructural requirements (included number and size of cages/ponds etc) based on the application. The CAR license also identifies the site-specific monitoring requirements, if applicable.

The legislation concerning aquaculture development in England and Wales is slightly different. Permission for consent to discharge wastes from pond and raceway farms is explicitly not included under the WFD legislation (The Water Environment (Water Framework Directive) (England and Wales) Regulations 2003). Instead discharges are managed under the Prevention of Pollution and Control (PPC) regulations 2000 (UK, 2000). Under these requirements a fee is charged to the farm operator by the Environment Agency (EA) and the EA undertake all water quality assessments. In Northern Ireland consent to discharge is required under the Water Order (Northern Ireland) 1999. In a similar fashion to England and Wales a fee is charged and the regulatory authority carried out all monitoring requirements.

Aquaculture planning applications – freshwater sites

Applications for development of freshwater sites, such as for salmon smolts or trout production, are made to the Local (County) Planning Authority (LPA). Such an application is more often through a pre-application consultation with planning representatives initially, to discuss the application in general terms. Information required for such a meeting might include equipment details, requested production maxima, a general evaluation of infrastructure capacity, such as road access and a basic assessment of environmental impact. A typical example of the information required for a freshwater site application is as follows (UK, 1999):

- an ordinance survey map indicating the exact location and size of the site;
- confirmation of ownership or lease of the site, or letters of intent of sale or lease from owner;
- where appropriate, planning permission;
- a copy of the consent to discharge effluent granted by the Regulator (= Environment and Heritage Service, Water Management Unit, or written confirmation that the developer has applied for such consent under the Water Order (Northern Ireland) 1999);
- a business plan in support of the proposed operation.

Often companies planning to operate fish production facilities will have already conducted a feasibility study for a particular waterbody. Companies need to evaluate cost-effectiveness depending on the possible tonnage levels and environment effectiveness through assessment of local fish populations (in lakes specifically) or water abstraction for ponds and raceways, for example. There is a significant body of literature concerning, for example the Water Framework Directive (UK, 2008), from which the status of a waterbody and likely effects from aquaculture development can be determined. This in turn enables developers to determine how these might affect their aquaculture development plans, in terms of the infrastructure, size and design of their facility. Under current legislation freshwater sites are not required to enact the requirements of an EIA process.

Aquaculture planning applications and EIA – marine sites (mainly Scotland)

Until recently (2007) aquaculture development came under the direct coordinative control of the Crown Estate (CE), particularly for salmon in marine systems, but equally applicable to other species including Atlantic cod and halibut (Crown Estate, 1999). Authority was transferred to Local Planning Authority control in April 2007 through the Town and Country Planning (Marine Fish Farming) (Scotland) Order 2007. As a result the Scottish Government coordinated a consideration of the implications of EIA through a consultation and workshop series. This resulted in a revised methodology for the treatment of EIA for marine fish culture in Scotland (RPS Group PLC, 2007), which proposed a defined timescale for consideration of a marine fish farm application.

This process has not currently been evaluated, due to insufficient applications having been made, but it attempts to re-invigorate the EIA requirements in the EU Directive and also to simplify the requirement through "consideration of the risks of only those impacts that are liable to have a significant effect on the environment" (RPS Group PLC, 2007) and to reduce the shear volume of some EIAs, that would often contain an evaluation of all impacts no matter how small. In this context the Planning Advance Note PAN58 serves as the template for the process, which is outlined as follows:

- project initiation – 'Design with the Environment';
- screening;
- scoping and pre-application discussions;
- environmental studies;
- preparation of Environmental Statement (ES);
- submission of planning application with ES;
- review of the ES by Planning Authority and consultees (possible request for further information);
- evaluation of environmental information and other material considerations by the Planning Authority;
- decision: refuse or grant (with or without planning conditions); and
- implementation and monitoring.

With this in mind, following the formal application to the Planning Authority, it is they who coordinate initial responses (the screening assessment) from statutory consultees, which may result in either more information being provided outside the process of EIA, or a full EIA being required. The Planning Authority coordinates the statutory consultees' opinions and returns these in a single document (the screening opinion and scope for investigation) to the applicant as information that must be considered within the EIA.

Statutory consultees involved in the development of aquaculture in Scotland are (1) the Local Planning Authority (LPA), who issue planning consent, (2) the Scottish Environment Protection Agency (SEPA) who administer the regulatory control concerning the environment and who are the government's environmental regulators and responsible for issuing discharge consents for waste materials and (3) Scottish Natural Heritage (SNH), an NGO with responsibility for environmental and biological conservation in Scotland. In England and Wales 2 and 3 change to the Environment Agency (EA) and English Nature (EN) respectively and in Northern Ireland the Environment and Heritage Service (EHS). Such responses result in a screening opinion, highlighting the particular areas of concern. If sufficiently warranted, i.e. the impacts are deemed likely to be significant, then an EIA would be requested.

The requested EIA is reported in a single bound submission called an Environmental Impact Statement (EIS). The EIS requirements for marine fish farms are governed under EU Council Directive 97/11/EC, which amended Directive 85/337/EEC (see Annex 1). In Scotland a fuller explanation of the EIA requirements are also included in the SEPA fish farm manual (SEPA, 2005).. This EIS will contain the information relevant to nutrient and organic waste and medicines and will take the form of:

- a description of the physical characteristics and transport requirements of the project;
- a description of the existing environment. This includes baseline surveys to assess hydrography, sediment quality and characteristics in the proximity of the proposed cage sites;
- a description of the production processes;
- an estimate of type and quantity of expected residues and emissions from the cages;
- a description of those aspects of the environment likely to be significantly affected by wastes from the cage production, plus details of the potential effects on the waterbody as a whole;

- a description of the measures taken to avoid, reduce or remedy the impacts from nutrient and medicinal wastes;
- conclusions and
- non-scientific executive summary.

The onus in the EIA system in the UK is that the applicant must provide the necessary information to allow a determination of approval, or not, to be made at the applicant's expense. After delivery of the EIS, the applicant must make available copies of the EIS should the public require access to the information as part of wider consultation in the approval decision. The Planning Authority has the right to require a public hearing to determine whether the application can go ahead. Equally the public is free to object and make representation at a public hearing. Ultimately it is the Planning Officer who decides whether approval should be given or not.

Site monitoring requirements – marine and freshwater

In Scotland site monitoring is required at all marine sites and is the responsibility of the farm operator to pay for this to be carried out. The methods used are to a prescribed formula, which is notified to fish farmers through a regularly updated web-based manual (SEPA, 2005). The nature of the survey is dependent on the individual consent given by SEPA, but generally consists of either a "standard", "extended" or "site-specific" survey. The difference meaning simply the number of sampling stations required. All surveys are based on sediment quality criteria and sediment samples are analysed for macrobenthos (where a number of biological indices are calculated, primarily the Infaunal Trophic Index), organic carbon content, particle size, redox potential and where required, copper and zinc levels. In addition, samples are taken for analysis of concentration of the anti-parasite SLICE (active ingredient emamectin benzoate). All these parameters are compared with published Environmental Quality Standards (EQS) within an Allowable Zone of Effect (AZE) to see if the farm has passed or failed consent. As peak biomass generally occurs once during a production cycle the surveys are most often done at approximately two-year intervals. For the analysis of the anti-parasite compound used, samples must be collected within 110 days of a treatment. The locations of the sampling stations and the diameter of the AZE are often site specific depending on the local hydrography and modelled by the regulatory waste dispersion model DEPOMOD (Cromey *et al.,* 2002).

In Scotland there is to date no equivalent manual for freshwater ponds, tanks systems or cage-culture; though this is under development. For trout or pre-smolt salmon grown in cages in freshwater lochs (lakes), water samples are collected typically on a bi-monthly basis (six times per year) by SEPA. This is analysed for total phosphorus and Chlorophyll-a concentration. These are then compared to quality standards designed to characterize the trophic status of the waterbody. The implementation of the WFD is causing changes to this policy, where in more sensitive sites (typically where there is risk of failing to meet the requirements of the WFD) producers are required under their CAR license, to have some form of survey (yet to be defined and likely to be site specific) each year conducted at the farm operators' expense. This may be more detailed water quality measurements or a survey of sediments near to the farm.

Land-based cultures (mainly raceways for trout or, in Scotland, for pre-smolt salmon) rarely have similar conditions applied and farms are not specifically required to carry out water quality assessments. Most do, however, as part of their management practice and procedures. In England and Wales and Northern Ireland, where production is primarily based on pond and raceway culture no company is obligated to provide environmental monitoring (even though most do for internal management purposes).

In Scotland, freshwater farms have consents where quality of inflow and outflow water is compared. The samples are taken by the regulator. Conditions are site specific, for example:

- pH must be in the range 5–9;
- BOD of discharge must not exceed intake by more than 2 mg/l;
- the suspended solids level of the discharge must not exceed that of the intake water by more than 5 mg/l;
- the ammoniacal nitrogen content of the discharge must not exceed that of the inlet water by more than 0.5mg/l.

In all cases (marine and freshwater) a fee is charged for the consent by SEPA, the EA or EHS (depending on the country) in order to at least partially fund the monitoring the regulators undertake. In all instances failure to maintain the status defined by the environmental quality standards (in both marine and freshwaters) can result in sanctions being applied by the regulatory body. These can result in a reduction or removal of the consent to discharge wastes, in which the farm ceases operation. For serious infringement, the regulator has the power to take the operator to court, which might result in fines being imposed. However, there are no specific policies on "sanctions" and implementation of sanctions is not readily evaluated.

Use of veterinary medicines – Scotland

The authorization of veterinary medicines used for aquaculture requires a marketing authorization for its initial use and an individual, site specific discharge consent. Marketing authorization is granted by the Veterinary Products Committee (VPC), under the auspice of the Veterinary Medicines Directorate (VMD). Before this is granted there is a three phase procedure leading to an environmental risk assessment, under EU Directive 92/18. The discharge consents for individual fish farms are granted by SEPA based on the hydrographically modelled dispersion of the product on entering the environment. This consent is given in the form of a total amount of product per production cycle and has lead to the situation where fish production is limited by veterinary medicine use rather than nutrient waste entering the environment.

NORTH AMERICAN ENVIRONMENTAL MONITORING AND EIA REQUIREMENTS

Canada

Context

Canadian aquaculture is dominated by Atlantic salmon on both the Atlantic and Pacific coasts. The EIA and monitoring requirements of marine salmon cage culture is reviewed by Wilson *et al.*, (this volume). Other significant cultured species are primarily bivalve shellfish, in particular the blue mussel (*Mytilus* sp.) on the Atlantic coast (22 764 tonnes production in 2005; FAO, 2007). The focus of this review is shellfish culture, with occasional mention of finfish culture where this is relevant.

General regulation requirements

The aquaculture industry in Canada is overseen by a combination of federal, provincial and local authorities (FAO, 2007-2008 NALO Canada). There are a number of legislative, regulatory and licensing measures in place to minimize the effects of aquaculture on the marine and freshwater environment. Aquaculture operators are also bound by industry codes of practice, both at the national and provincial level. The main instruments include:

- The Fisheries Act;
- The Canadian Environmental Assessment Act;
- National Code on Introductions and Transfers of Aquatic Organisms;
- Finfish growers Codes of Conduct (salmon).

In Canada, the regulation of access to land and water for aquaculture development is under shared jurisdiction of federal, provincial and local governments. All proposals must go through an interagency referral process, which is coordinated at provincial level. The federal Department of Fisheries and Oceans Canada (DFO) coordinates, in conjunction with the provincial bodies, the review of aquaculture applications and is responsible for ensuring compliance with the Fisheries Act (1985).

Freshwater finfish aquaculture operations are on privately owned land, whereas coastal aquaculture normally occupies provincially (state/crown) owned foreshore. The latter requires an aquaculture license under the provincial Fisheries Act (1996) and a crown land tenure (lease) under the provincial Land Act (1996). Both requirements can be processed and approved at a single location, the Ministry of Agriculture and Lands. This body takes environmental issues into account as well as siting criteria, coastal resource plans and First Nations rights into account, when making a decision. If successful, a five year license is normally issued within which time the aquaculture developer is required to prove the suitability of the site for development. If within this time the developer has not done so then potentially a license can be issued for further development; or the EIA and full application has proved successful a longer 20 year license is given. This legislation is relevant to both fish and shellfish culture sites.

EIA requirements – shellfish

Under the Canadian Environmental Assessment Act (1992) (CEAA), Transport Canada must conduct an environmental assessment for marine aquaculture development. Screening factors are defined under the Act related to environmental impacts, public consultation and mitigation measures to reduce impacts (Figure 5). Essentially, for shellfish farming the DFO (in consultation with stakeholders and other legislative bodies) make the decision as to whether an EIA is required or not, whilst taking into account the size and type of development (see Annex 2). It thus determines what the scope of the EIA will be under the CEAA (DFO, 2002a):

- the project;
- contact information;
- physical location and site detail;
- design & operational plans;
- existing environment;
- aquatic environment;
- biological environment;
- socio-economic environment;
- public consultation;
- changes to the project caused by the environment;
- cumulative environmental effects.

In the context of the EIA process there is also a primary place for the public to become involved in the assessment. The competent authority is required to place much information on government registries, which are then open for access. The public is thus able to:

- review information registered on the CEA Agency's Federal Environmental Assessment Index (FEAI) at: www.ceaa.gc.ca/0008/index_e.htm;
- review a public registry that is maintained for every EIA to facilitate convenient public access to the records relating to the EIA;
- where the regional authority is of the opinion that public participation in the screening of a project is appropriate, they may provide the public an opportunity to review and comment upon the screening report and any record in the public registry.

Importantly any comments from the public received by the regional authority have to be considered in the environment impact assessment process.

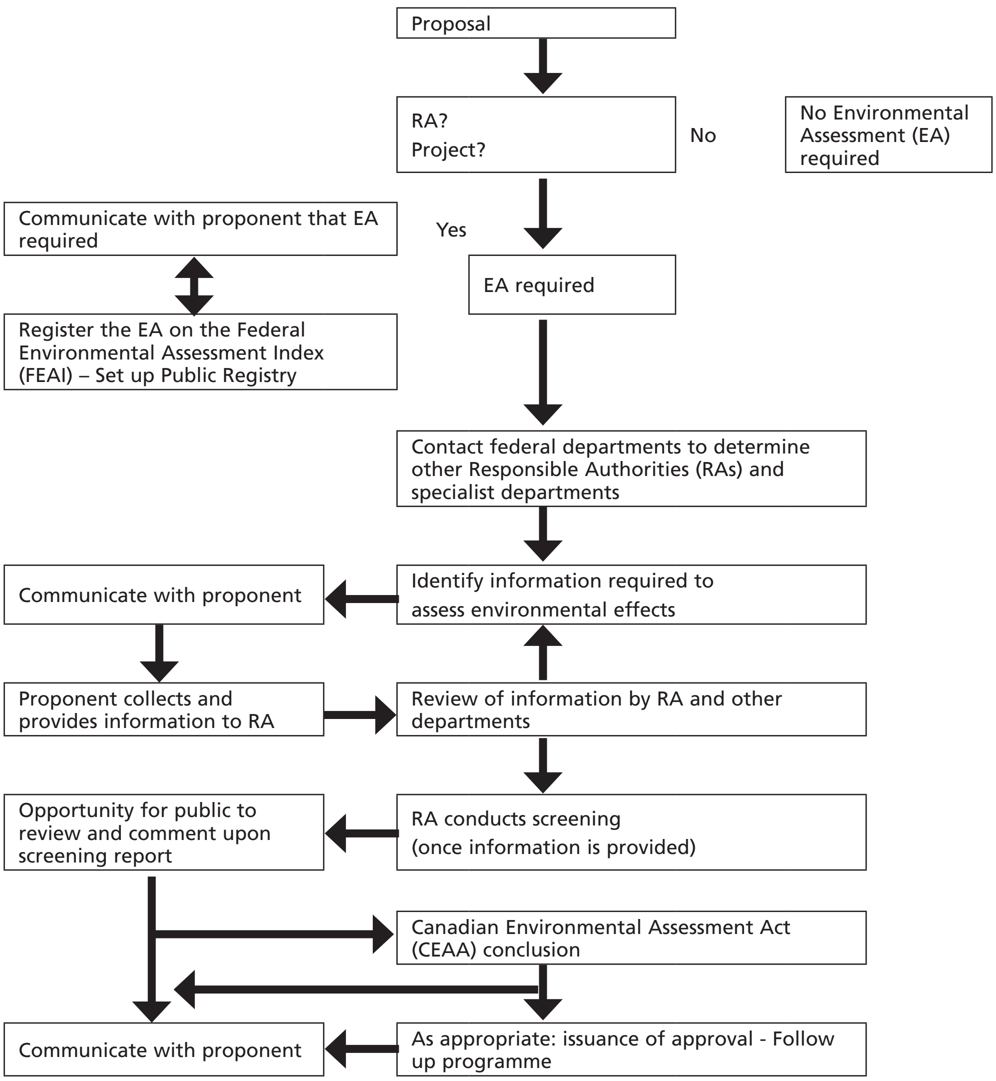
The potential for adverse effects are determined by comparison with the predicted environmental quality after development with the present conditions. This approach uses baseline data accumulated either from published information or new data collected as part of the EIA process. The significance of any adverse effects is then assessed using the following criteria defined by the Canadian Environmental Assessment Agency:

- the magnitude and severity of the adverse effect;
- the degree to which this effect is reversible or not;
- the ecological context of the adverse effect in terms of the ecosystem.

Under these criteria the significance is determined using environmental standards or using a quantitative risk assessment approach, which assumes an "acceptable" level of risk. If these assessments are not possible the DFO has the ability to apply a "best professional judgement" decision of significance of effect. Finally, the likelihood of this significant effect happening in the particular locality is determined using a "probability of occurrence" approach (DFO, 2002b).

Much of the above process can be presented in an easily understandable format using a risk matrix. An example for shellfish farming is given in Annex 3. The significance

FIGURE 5
The screening process for EIA as designated by the CEAA monitoring requirements (DFO, 2002b)



of an effect on a specific aspect of the environment (also known as Valued Ecosystem Components – VECs) and mitigation measures for all project activities are defined, as well as the determination of the significance of the effect, the requirements for follow up monitoring for each effect are also recorded.

DFO and other federal, provincial and territorial government departments monitor aquaculture operations. This may be done by reviewing monitoring data gathered by aquaculture operators as part of the requirements of their licence, lease or other approval, or by conducting periodic on-site audits of operations.

Ongoing monitoring is usually a requirement of provincial licences or approvals. Provinces often require that aquaculture operators report on the performance of their sites by measuring certain indicators in the environment that tell regulators what kinds of environmental effects might be occurring at the site. Provincial and federal officials may also visit farm sites to evaluate firsthand how well the farm is operating. Provinces also share monitoring information with federal agencies.

DFO and provincial agencies are responsible for the development of mutually agreed upon monitoring requirements, standards and methods for assessing the effects of aquaculture operations. However, Environment Canada (who is responsible for preservation and enhancement of the quality of the natural environment and the protection of Canada's water resources) coordinates environmental policies and programmes for the federal government, and remains responsible for regulating the deposits of deleterious substances into fish bearing waters. DFO supports Environment Canada in identifying options for regulating the deposit of deleterious substances by aquaculture operations and in the development of industry best management practices designed to avoid deposits due to aquaculture activities.

The DFO's guide to the environmental assessment of marine finfish aquaculture projects (see: DFO, 2008) identifies the information required to assess the environmental effects of marine aquaculture operations of most finfish species under the Canadian Environmental Assessment Act (CEAA). The documents are intended to encourage consistency in the application of DFO's review processes across regions. However, in some circumstances, regions may determine that it is appropriate to require less information than is outlined in the guides.

Factors which may affect the level of information and monitoring required include:

- the size, scope and type of the proposed operation, (e.g. Atlantic cod grow-out, may require less than an Atlantic salmon farm);
- the extent of other activities in the area;
- site characteristics;
- the temporal utilization cycle (e.g. continuous occupation, fallow periods, seasonal operation).

There are a number of oceanographic and water quality requirements:

- range of depths through site (metres) maximum depth at yearly highest tide (metres);
- minimum depth at yearly lowest tide (metres);
- minimum depth between bottom of aquaculture facilities / structures (i.e., cages) and seafloor at lowest tide (metres);
- direction of maximum fetch;
- estimated maximum wave height (metres). monthly average temperature profile, plus annual minimum and maximum water temperatures at the site;
- salinity profile, plus annual minimum and maximum salinity values for the site;
- oxygen profile taken at the deepest location during late summer or early autumn, plus Secchi disc depth;
- list any other known organic matter inputs and/or sources of contaminants that may exist within the bay or in close proximity to the site, e.g. raw sewage, agriculture, forestry, fish processing.

The Canadian Shellfish Sanitation Program (CSSP), jointly administered by DFO, Environment Canada and the Canadian Food Inspection Agency (CFIA), provides for the continuing evaluation and classification of the level of contamination in the water overlying shellfish growing areas (DFO, 2002a). If the proposed site is located within a shellfish classification area, the current classification and the date of the most recent survey must be specified. If not, the location of and distance to the nearest classified area and the date of its most recent survey must be specified.

The current regime must be described (e.g., circular, vortex, seaward, landward, inflow/outflow) and the following information on currents at the site must be provided:

- the tidal slack period (minutes);
- average current speed (cm/s);
- minimum current speed (cm/s);
- maximum current speed (cm/s);
- predominant current direction(s).

Further information on the sea bed sediments are required for monitoring on environmental impacts:

- underwater visual survey of the seafloor beneath the potential site where turbidity and depth permit, including an assessment of substrate type, abundance of flora and fauna, plus other habitat features;
- particle-size analysis;
- percent organic matter content in the sediment;
- redox (Eh) and sulphide data for the benthic environment.

The DFO uses information from the Eh and sulphide measurements and the underwater video survey, to determine existing sediment conditions.

Environment Canada also recommend that if there are other aquaculture operations, agricultural and/or other industrial activities contributing discharge or runoff to the receiving water, the assimilative capacity of the waterbody should be considered. Assimilative capacity can be determined by a number of physical, chemical and biological factors. Chemical factors may include nutrient levels (e.g. nitrogen, phosphorus), biological factors include plant composition and abundance; fish types and abundance; and the composition of invertebrate populations.

Nova Scotia – an example of aquaculture environmental monitoring at the provincial level in Canada

Due to the expansion of all forms of species culture within the aquaculture industry, increased public concern and a commitment to ensure environmental sustainability, the Nova Scotia Department of Fisheries and Aquaculture (DFA) implemented an adaptive province-wide Environmental Monitoring Program (EMP) in autumn 2003 (DFA, 2006).

Monitoring is conducted on both aquaculture leases and at reference stations and consists of collecting qualitative (video) and quantitative (sediment and water analysis) data from coastal areas throughout Nova Scotia. The EMP focuses on the potential effect of aquaculture on bottom sediment rather than the water column and follows a risk-based approach that recognizes increased risk requires increased monitoring.

All sites currently in production are tested and those with larger production are given higher priority. Sites of potential concern are subject to repeat sampling and, if required, remediation action is implemented. Through scientific research, Environmental Quality Definitions (EQDs) have been established as a means of classifying the level of environmental change in marine sediments (see Table 4). The EQDs contain both qualitative and quantitative variables. For regulatory purposes, the focus is on sediment geochemistry and analysis of marine sediment is based on the measurement of total dissolved sulphide, redox, organic content and porosity. The

Nova Scotia DFA state that sulphide is a sensitive indicator of habitat degradation due to organic loading and is the main parameter currently used to determine direct impact of an aquaculture operation. Porosity is the percentage of pore volume or void space, or that volume within any material (e.g. bottom sediment) that can contain water. Porosity is also known as sediment water content and can be used to interpret recent deposition at the sediment surface (DFA, 2006).

The EMP now has a record of the specific effects to the marine environment around aquaculture sites in Nova Scotia. It has been found that once sites have been measured multiple times in different seasons, it is possible to measure the risk of environmental impact. With this large baseline data set DFA can now assess risk between sets of alternate aquaculture strategies, such as comparing finfish vs. shellfish, bay vs. site, active site vs. non-active site. Such a system aids the decision-making process.

The EMP employs similar methods to sample a diverse aquaculture sector that includes both big and small finfish and shellfish operations located in a variety of marine ecosystems. It is the first time that such a programme has been carried out in Nova Scotia and is the first time that empirical evidence exists on an industry-wide scale. It is hoped that the growing body of data collected will go a long way to ensure that aquaculture in Nova Scotia remains environmentally sustainable (DFA, 2006).

United States of America

Context

Freshwater aquaculture production in the United States of America is dominated by the culture of channel catfish, which accounted for 275 754 tonnes out of a total of 337 021 tonnes produced in 2005 (FAO, 2007). Rainbow trout (27 504 tonnes) and crawfish (16 355 tonnes) also account for a large percentage of the total production. These three species accounted for 95 percent of the freshwater production in 2005. Within the marine sector, excluding salmon, 125 536 tonnes were produced in total in 2005 (FAO, 2007), which was dominated by the production of three shellfish species: the American cupper oyster (55 188 tonnes) on the Atlantic west central coast, and the quahog (38 635 tonnes) and the Pacific cupper oyster (21 323 tonnes) on the Pacific northwest coast.

Regulation

Aquaculture in the United States of America is regulated at both state and federal levels (FAO, 2006-2008 NALO USA). At the federal level regulation of aquaculture is done by the Food and Drug Administration (FDA), the US Department of Agriculture (USDA) and the US Environmental Protection Agency (USEPA). Other federal agencies that have an advisory role within aquaculture regulation are the National Oceanic and Atmospheric Administration (NOAA), the Department of Commerce, the Joint Subcommittee on Aquaculture (JSA) and the US Fish and Wildlife Service (FWS). The role of these federal agencies relates to the trade of goods and services from various sectors between states or with other countries, hence they are not specific to aquaculture.

At a federal level EIA regulations do not specifically require that aquaculture undergoes an EIA. Therefore in most US states an Environmental Impact Assessment is not required to register an aquaculture facility. However, before the permit for aquaculture is issued an application must be submitted that contains much of the production and practice information contained within an EIA. Some states are beginning to require EIA for aquaculture development, which stems from respective state plans for the development of the industry. For example California had become the first in 2006 to maintain "comprehensive controls on future fish farming…" (Kay, 2006) with an EIA being required for any form of aquaculture development (California Fish and Game Commission, 2007). This is transposed into a Project Environmental Impact Report or "PEIR". Available for public assessment the PEIR is used to evaluate

TABLE 4
Environmental quality definitions for Nova Scotia marine aquaculture monitoring

	Measurement	Norm-oxic	Sub-oxic	Anoxic
Qualitative measures (from video & sediment observations)	Sediment colour	Tan to depth of > 0.5 cm	Tan to < 0.5 cm and/or patchy black sediments at surface	Surface sediments black
	Microbial and algal (plant presence)	No sulphur bacteria present (also benthic micro-algae or macro-algae at shallow sites)	Patchy or occasional sulphur bacteria and cyanobacterial biofilms	Sulphur bacteria may be widespread
	Macrofaunal (animal) assemblages	Wide array of infauna and epifauna; may include large burrowers	Mixed assemblages of small infauna which may include larger animals	Small infauna or tube-dwellers at shallow sediment depths
Quantitative measures (from sediment analysis)	Redox (mV)	0 to 300	-100 to 0	< -100
	Sulphide (μM)	<1300	1300 to 6000	> 6000
	Organic content (%)	≤ reference*	1.5 to 2 x reference	> 2 x reference
	Porosity (%)	≤ reference*	1 to 10 x reference	> 10 x reference
Site classification		**Type A**	**Type B**	**Type C**

(*) Values compared to reference assume that reference and lease stations would have had similar levels in pre-culture conditions.

Source: Smith et al., 2002.

the impacts of the aquaculture development and is a key to gaining the appropriate licence to operate. Such a requirement is not specific to all US states.

More detailed environmental regulation of aquaculture exists at state level. Each state is responsible for regulation of aquaculture and each framework varies slightly in its implementation. However, in general principles adopted can be described as follows. All marine aquaculture activities within three miles of the coast are subject to state regulation and these activities must under law be registered with the relevant department, stating the owner, species grown and location of the activity.

Wastewater discharge and water quality are controlled at both federal and state levels, therefore approval must be sought from both the state (regulatory authorities vary with state) and the EPA to discharge pollutants into inter-state waters, under the Federal Water Pollution Control Act. This involves issuing a permit under the National Pollutant Discharge Elimination System (NPDES) programme. The permitting authority is usually at state level overseen by the EPA. A list of the Departments for Environmental Protection for each state is given in USEPA (2006). The required permit:

- identifies outfall points from which facility discharges wastewater to surface waters;
- sets requirements to protect the quality of surface water (such as pollution concentration limits, management practices and record keeping) that the discharger must meet;
- allows an operation to discharge pollutants as long as the operation meets the requirements in the permit.

Under the Concentrated Aquatic Animal Production (CAAP) programme and Effluent Limitations Guidelines (ELGs), new performance standards for aquatic animal production were established by the EPA in 2004 (USEPA, 2006). This establishes effluent limits for aquaculture systems producing more than 100 000 lbs (approximately 45 tonnes) of fish per year in flow-through, re-circulating or net-pen systems, which reduce suspended solids, nutrients and drugs and chemicals used to manage fish health. Tables 5 to 8 summarize the CAAP requirements for land-based and net pen fish culture (USEPA, 2006).

The following types of aquaculture are not covered by the CAAP programme and therefore are not subject to ELGs:

- molluscan shellfish (including nurseries);
- shrimp ponds;

- crawfish production;
- alligator production;
- aquaria;
- net pens rearing native species released after a growing period of no longer than four months to supplement commercial and sport fisheries.

There are several elements to a NPDES permit for CAAP systems. There are:

- **Cover page –** serves as the legal notice of the applicability of the permit, provides the authority under which it is issued and contains appropriate dates and signature(s).
- **Effluent limitations and standards –** serves as the primary mechanism for controlling discharges of pollutants to receiving waters (e.g., the specific narrative or numeric limitations applied to the facility and the point of application of these limits).
- **Monitoring and reporting requirements –** identifies all of the specific conditions related to the types of monitoring to be performed, the frequencies for collecting samples or data and how to record, maintain and transmit the data and information to the permitting authority.
- **Record-keeping requirements –** specifies the types of records to be kept on-site at the permitted facility (e.g., inspection and monitoring records).
- **Special conditions –** in NPDES permits for CAAPs, special conditions may be included, as determined necessary by the permitting authority.
- **Standard conditions –** conditions that apply to all NPDES permits, such as the requirement to properly operate and maintain all facilities and systems of treatment and control, as specified.

As part of the permit application a Best Management Practice (BMP) plan should be submitted and certified. These differ slightly for flow through systems and net-pen culture. The BMP plan for flow-through systems should describe how the producer will achieve:

- solids control;
- material storage;
- structural maintenance;
- record-keeping;
- training.

In addition to those above, for net-pen culture the BMP plan must show how the following are achieved:

- feed management;
- waste collection and disposal;
- transport or harvest discharge;
- carcass removal.

The plan must be kept on site and made available on request. More detail on each of these requirements is given in USEPA (2006), where an example of a BMP for a flow through system is given along with examples of required record keeping forms. More detail on best management practices for aquaculture in the United States of America is given in Tucker *et al*., (2003), where advice on topics such as initial site selection, feed management, solids management and disposal and management of escapes are given for flow-through, net-pen, re-circulating and pond aquaculture systems. General aspects of BMPs in the United States of America are highlighted in Box 1.

The EPA is also responsible for the Coastal Water Quality Monitoring Programme (USEPA, 2006). This programme monitors the state of coastal ecosystems and coordinates monitoring activities of other agencies to enable the issue of a permit where waste discharge will not unreasonably degrade or endanger human health, welfare, amenities, the marine environment, ecological systems, or economic potentialities. The EPA offers many types of compliance assistance and incentives to help aquaculture

BOX 1

BMPs and aquaculture

Best Management Practices (BMPs) are used widely across the United States of America. The benefits of BMPs are greatest for activities where pollution is the sum of effects of several activities separated in time and conducted over a relatively large area. This situation is characteristic of non-point source pollution from aquaculture. State environmental management agencies are responsible for designing such BMPs, which allows for some flexibility as a specific set of BMPs can be prescribed for all producers, or tailored for each facility (see Tucker *et al*., 2003).

Title 40 of the Code of Federal Regulations Part 122.2 defines BMPs as schedules of activities, prohibitions of practices, maintenance procedures and other management practices that prevent or reduce pollution. Although BMPs have traditionally focused on good housekeeping measures, BMPs may be used in a wide variety of pollution prevention activities. When used as part of a regulatory activity, BMPs are most often used:

1. to reduce pollution from activities ancillary to industrial processes (such as runoff from a plant site, spillage or leaks and so on);
2. in situations where numerical limits are not feasible;
3. in situations where they are necessary or best suited to achieve numerical limits.

When used as part of the regulatory process, BMPs are developed into formalized plans that become an enforceable part of the National Pollutant Discharge Elimination System (NPDES) permit for the facility.

In addition, voluntary adoption of BMPs, installation of BMPs to comply with product certification standards and application of BMPs to meet requirements of effluent permits are straightforward processes over which producers have complete control. They can adopt BMPs according to individual discretion and site characteristics, or they may choose to operate without BMPs. Potential problems can arise if BMPs are mandatory and especially if a specific suite of BMPs is prescribed for an entire industry.

operations comply with environmental requirements. EPA is also responsible for conducting a federal regulatory enforcement programme with respect to environmental requirements. The National Pollutant Discharge Elimination System (NPDES) controls direct discharges into navigable waters. NPDES permits, issued by either EPA or an authorized state, contain aquaculture-specific, water-quality-based limits and establish pollutant monitoring and reporting requirements.

Any aquaculture facility that intends to discharge into the Nation's waters must obtain a permit before initiating a discharge. A permit applicant must provide quantitative analytical data identifying the types of pollutants present in the facility's effluent. The permit will then set forth the conditions and effluent limitations under which a facility may make a discharge (USEPA, 2008).

More generally the information gives the monitoring and reporting requirements for dischargers authorized to discharge under the NPDES General Permit for Discharges from Aquaculture and Aquariums (General Permit), unless such monitoring and reporting requirements are modified or waived by the executive officer responsible within the relevant state body. Both inflow and outflow waters are monitored: 1) Influent monitoring – Representative influent water samples should be collected concurrently with effluent samples and analysed for total suspended solids (TSS), pH, turbidity and temperature. 2) Effluent monitoring – Sampling station should be established to obtain representative samples of the discharge before it fully mixes with the receiving water(s) or any other water flows. The representative samples of the discharge are collected and analysed according to Table 8.

TABLE 5
Summary of general reporting requirements for flow-through, recirculating and net pen facilities (after USEPA, 2006)

General reporting requirements	
Drugs	
1) Reporting of intention to use Investigational New Animal Drug Exemptions (INADS) where such use may lead to a discharge of the drug to waters of the United States of America.	• Provide the permitting authority with a written report, within seven days of agreeing or signing up to participate in and INAD study. • Identify the INAD to be used, method of use, dosage and the disease or condition the INAD is intended to treat.
2) Oral reporting of INAD and extra-label drug use	• Provide an oral report to the permitting authority as soon as possible, preferably in advance of application, but no later than seven days after initiating use of the drug. • Identify drugs used, method of application and the reason for adding that drug.
3) Written reporting of INAD and extra-label drug use	• Provide a written report to the permitting authority within 30 days after initiating use of the drug. • Identify drugs used and include the reason for treatment, date(s) and time(s) of the addition (including duration), method of application and the amount added.
Failure or damage to the structure of aquatic animal containment system	
1) Specification of reportable damage and/or material discharge	• The permitting authority may specify in the permit what constitutes reportable damage and/or material discharge of pollutants, based on consideration of production system type, sensitivity of the receiving waters and other relevant factors.
2) Oral reporting of structural failure or damage	• Provide an oral report within 24 hours of the discovery of any reportable failure or damage that results in a material discharge of pollutants. • Describe the cause of the failure or damage in the containment system. • Identify materials that have been released to the environment as a result of the failure.
3) Written reporting of structural failure or damage	• Provide a written report within seven days of the discovery of the failure or damage. • Document the cause of the failure or damage. • Estimate the time elapsed until the failure or damage was repaired. • Estimate materials released to the environment as a result of the failure or damage. • Describe steps being taken to prevent a recurrence.
Spills	
1) Oral reporting of spills of drugs, pesticides and feed	• Provide an oral report to the permitting authority within 24 hours of any spill of drugs, pesticides and feed that results in a discharge to waters of the USA. • Identify the material spilled and quantity.
2) Written reporting of spills of drugs, pesticides and feed	• Provide a written report to the permitting authority within seven days of any spill of drugs, pesticides and feed that results in a discharge to waters of the USA. • Identify the material spilled and quantity.

To facilitate this for all aquaculture effluents a log is maintained of the condition and quarterly visual observations made, of the receiving water(s) at the point of discharge and at environmental monitoring stations RW-1 and RW-2, where:

Discharges to inland surface waters –
RW-1 = 100ft (30.48m) upstream from the discharge point.
RW-2 = 100ft downstream from the discharge point.
Discharges to ocean waters –
RW-1 = 100ft up coast of the point of discharge, or beyond if receiving water appears affected.
RW-2 = 100ft down coast of the point of discharge, or beyond if receiving water appears affected.

The observations stated include the presence or absence of the following conditions:

- floating or suspended matter in the water;
- discoloration of the water;

- bottom deposits;
- visible films, sheens or coatings;
- fungi, slimes, or objectionable growths;
- potential nuisance conditions.

If deemed necessary, the executive officer can also require the discharger to submit analytical data of receiving water quality and/or photographic documentation of receiving water conditions *in lieu* of visual observations.

In addition, the following information on treatments, disinfectant and other chemicals in the discharge are submitted with each monitoring report:

- the name(s), active ingredient(s), label instructions and restrictions, Material Safety Data Sheets and amount(s) of all drug(s), disinfectant(s), or other chemical(s) used. As well as the dates and frequency of application;
- the treatment concentration(s) of the active ingredient(s), duration of treatment, whether the treatment was static or flush, amount in gallons or pounds of the drug, disinfectant, or chemical and the flow in cubic feet per second [2] (cfs) of the influent to the treatment tank;
- the quantitative measure of the active ingredient, or the estimated concentration of the active ingredient in the effluent at the point of discharge to the receiving waters;
- the flow (in cfs) during chemical usage at the point of discharge to the receiving waters.

TABLE 6

Summary of narrative requirements for flow-through and recirculating facilities, continued (after USEPA, 2006)

Narrative requirements	
Best Management Practices plan (BMP)	
1) Development and maintenance of a BMP plan on site that describes how the permittee will achieve the following five requirements:	
a) Solids control	• Employ efficient feed management and feeding strategies that limit feed input to the minimum amount reasonably necessary to achieve production goals and sustain targeted rates of aquatic animal growth in order to minimize potential discharges of uneaten feed and waste products to waters of the USA. • Identify and implement procedures for routine clearing of rearing units and offline settling basins. • Identify procedures for inventorying, grading and harvesting aquatic animals that minimize discharge of accumulated solids. • Remove and dispose of aquatic animal mortalities properly on a regular basis to prevent discharge to waters of the USA, except where authorized by the permitting authority in order to benefit the aquatic environment.
b) Material storage	• Ensure proper storage of drugs, pesticides and feed in a manner designed to prevent spills that may result in the discharge of drugs, pesticides, or feed to the waters of the USA. • Implement procedures for properly containing, cleaning and disposing of any spilled materials.
c) Structural maintenance	• Routinely inspect production systems and wastewater treatment systems to identify and promptly repair damage. •Regularly conduct maintenance of production systems and wastewater treatment systems to ensure their proper function.
d) Record-keeping	• Maintain records for aquatic animal rearing units documenting feed amounts and estimates of the numbers and weights of aquatic animals in order to calculate representative feed conversion ratios. • Keep records documenting frequency of cleaning, inspections, maintenance and repairs.
e) Training	• Train all relevant personnel in spill prevention and how to respond in the event of a spill to ensure proper clean up and disposal of spilled materials. • Train personnel on proper operation and cleaning of production and wastewater treatment systems, including feeding procedures and proper use of equipment.
2) Make the plan available to the permitting authority upon request	
3) Certify that a BMP plan has been developed	

[2] 1 cubic foot per second is equivalent to 0.028 cubic meters per second.

TABLE 7

Summary of narrative requirements for net pen facilities (after USEPA, 2006)

Narrative requirements	
Best Management Practices plan (BMP)	
1) Development and maintenance of a BMP plan on site that describes how the permittee will achieve the following eight requirements:	
a) Feed management	• Employ efficient feed management and feeding strategies that limit feed input to the minimum amount reasonably necessary to achieve production goals and sustain targeted rates of aquatic animal growth. • Minimize accumulation of uneaten food beneath the pens through active feed monitoring and management strategies approved by the permitting authority.
b) Waste collection and disposal	• Collect, return to shore and properly dispose of all feedbags, packaging materials, waste rope and netting.
c) Transport or harvest discharge	• Minimize any discharge associated with the transport or harvesting of aquatic animals (including blood, viscera, aquatic animal carcasses or transport water containing blood)
d) Carcass removal	• Remove and dispose of aquatic animal mortalities properly on a regular basis to prevent their discharge into the waters of the USA.
e) Materials storage	• Ensure proper storage of drugs, pesticides and feed in a manner designed to prevent spills that may result in the discharge of drugs, pesticides, or feed to the waters of the USA. • Implement procedures for properly containing, cleaning and disposing of any spilled materials.
f) Maintenance	• Routinely inspect production systems in order to identify and promptly repair damage. • Regularly conduct maintenance on the production system to ensure its proper function.
g) Record-keeping	• Maintain records for aquatic animal net pens documenting feed amounts and estimates of the numbers and weights of aquatic animals in order to calculate representative feed conversion ratios. •Keep records of net changes, inspections and repairs.
h) Training	• Train all relevant personnel in spill prevention and how to respond in the event of a spill to ensure proper clean up and disposal of spilled materials. • Train personnel on proper operation and cleaning of production system, including feeding procedures and equipment.
2) Make the plan available to the permitting authority upon request	
3) Certify that a BMP plan has been developed	

TABLE 8

Parameters to be analysed from samples of the aquaculture facility discharge (from: NPDES general permit for discharges from aquaculture and aquariums)

Constituent	**Units**	**Type of sample**	**Minimum sampling and analysing frequency**
Flow	MGD	Metered	Weekly
Settleable Solids	mL/L	Grab	Quarterly
Total Suspended Solids	mg/L	24-hour composite	Quarterly
Net Total Suspended Solids	mg/L	Calculated	Quarterly
Turbidity	NTU	24-hour composite	Quarterly
Net Turbidity	NTU	Calculated	Quarterly
pH	units	Grab	Quarterly
Temperature	°F	Grab	Quarterly
Dissolved Oxygen	mg/L	Grab	Quarterly
BOD	mg/L	24-hour composite	Semi-Annually (June and Dec)
Grease and Oil	mg/L	24-hour composite	Semi-Annually (June and Dec)
Ammonia (as N)	mg/L	24-hour composite	Semi-Annually (June and Dec)
Nitrite (as N)	mg/L	24-hour composite	Semi-Annually (June and Dec)
Nitrate (as N)	mg/L	24-hour composite	Semi-Annually (June and Dec)
Total Coliform	MPN/100mL	Grab	Semi-Annually (June and Dec)
Faecal Coliform	MPN/100mL	Grab	Semi-Annually (June and Dec)
Enterococcus	MPN/100mL	Grab	Semi-Annually (June and Dec)

Source: USEPA, 2002

The use of medicines in aquaculture is becoming an ever more important issue in the United States of America as the aquaculture industry expands. The use of these products is regulated both at federal and state levels, depending on implementation of law. All new drugs are registered and bi-annual records of drugs sold are provided to the FDA under the Animal Drug Availability Act (1996; see FDA, 2007, for Green Book). A guide to their use in aquaculture has recently been updated by the Federal Joint Subcommittee on Aquaculture Working Group on Quality Assurance in Aquaculture Production (JSA, 2007). In summary this makes the following recommendations for use of federally regulated products:

- Obtain a diagnosis of the problem(s) before applying any treatment.
- Seek professional advice if ever in doubt as to when or how to use regulated products.
- Use regulated products only for those species and indications listed on the label, unless extra-label use is specifically prescribed by a licensed veterinarian.
- Read and follow directions for use on the product label carefully.
- Use the proper dosage, amount, or concentration for the species, area and/or specific condition.
- Use the correct method and route of application or administration, whether by spraying aquatic vegetation, water treatment (ponds, tanks, or immersion), injection or oral administration (used with medicated feed and some biologics).
- Calculate withdrawal times accurately.
- Identify treated populations or stocks with clear markings of production and holding units.
- Do not use antibiotic drugs or medicated feed for disease prevention unless they are specifically approved for that use.
- Do not substitute unlabeled or generic products or trade-name products that are labelled and approved for aquaculture or aquatic site uses.
- Keep accurate records.
- Consider the environmental impact of discharging treated water, including possible effects on non-target organisms.
- Adopt a producer quality assurance programme or a HACCP programme that provides guidelines for preventing tissue residue violations and for producing high-quality, wholesome products for consumer use.
- Be aware of requirements concerning personal safety measures and proper procedures for farm workers and pesticide applicators that handle or apply regulated products.
- Consider the economic consequences, both short- and long-term, of treatment before using a regulated product.

There is no specific guidance on how to implement some of these recommendations, such as monitoring the environmental impacts of discharging treated water.

CONCLUSIONS

Europe

Within the context of European Union legislation the consideration of the need for an Environmental Impact Assessment for aquaculture development is implicit in the EIA Directive (EU Directive 337/1985/EEC; as amended by Directive 97/11/EC). Carrying out an EIA for the aquaculture production of animals is listed as a Group 2 requirement, where the need for an EIA is dependant upon the view expressed by local officials. In general this requirement is embedded at nation state level; within either aquaculture-specific EIA legislation, as in the UK for marine culture of salmonids, or more generally as in the majority of the accessions countries (e.g. Hungary, Poland) and in some cases not at all (e.g. Italy, Netherlands). Unfortunately, across most European countries (although not all) there is a differential requirement for the treatment of aquaculture development in marine systems, which manifests itself as a requirement to carry out an EIA for finfish culture but not for shellfish culture. The requirement to carry out an impact assessment for the development of freshwater facilities is also variable within countries and no country reviewed had specific freshwater aquaculture EIA legislation, and most (based on the available literature) had never implemented the need for an EIA in freshwater culture.

Across Europe the implementation of EIA for any form of aquaculture development is very variable. Mostly it has not been possible to access information on specific cases and therefore the specific practices employed could not be determined. However, the impacts of aquaculture on the environment in general are well understood through research. The specific methods employed to assess impacts on the sea bed, for example, are similar across the world, even though the number of samples required and the location from which they are taken are variable; both within countries, within regions and invariably between sites.

There appears, also, to be a general inconsistency with the level of data and supporting information that is required and what specific information is needed to compile an Environmental Impact Statement. Most countries reviewed appeared to require an assessment of the likely impact on the site, for example through an assessment of wastes and dispersal. Hardly any country required the development of a risk matrix which would itemise the activities, likely impacts, mitigation measures and monitoring requirements. Much of the literature concerning this is either unavailable or so embedded within more general EIA requirements that it is not obvious.

In most of the countries reviewed there was no apparent centralised system of advice. In most cases municipal, regional and local government officials were required to interpret and implement more general EIA legislation. This appears to result in a significant amount of time and effort needed to gain the appropriate permissions. Certainly permissions must be granted and this is reflected in all European countries requiring some form of application procedure and license. What appears differential is the extent of involvement of various government bodies within each country. Reviews of the procedures in Italy and Greece, for example, showed that the level of bureaucracy may result in applications taking years to either be permitted or not. This requires significant stamina on the part of both the applicant and the various bodies involved in such procedures and surely must be an impediment to the long-term future development of the aquaculture industry in Europe. Certain countries, such as Scotland within the UK, are attempting to make clear the application and EIA requirements through a series of stakeholder conferences and the implementation of specific templates to aid the process.

Not least such development requires an overall strategy concerning aquaculture development so that the aquaculture industry and their specific applications can be viewed in the context of a grand plan. Perhaps this is the reason why development and implementation of EIA and monitoring plans for aquaculture have not been developed so well in the accession countries, which clearly have different priorities to build and develop their respective industries after years of neglect. However, such development should probably work within the confines of given EIA legal frameworks in order to remain sustainable.

Although certain countries appear not to implement the explicit requirement of the EU EIA Directive, nearly all use other methods of controlling development in the aquaculture industry. This results in variable amounts of information being required in support of an aquaculture application. In Greece there seems to be a well defined requirement to consider specific impacts which can result in the developer being uncertain about exactly what to include in the EIA. For site specifications alone the Greeks required measures of non-specific such as physicochemical parameters in the marine environment, suspended solids, wave height, the direction and speed of the wind, the direction and speed of the water currents, depth, substrate type of the sea bed and the structure of the macrobenthic community. In comparison Spain appears to have a very long list of parameters (such as 12 metal forms) that may require evaluation as part of an EIA.

North America

In North America the implementation of the EIA process is inconsistent between the two countries evaluated and none more so that in the United States of America. Here there appears to be a general disregard for the EIA process in aquaculture development. Marine production of fish species in the United States of America is relatively low and therefore most species produced were not specifically part of this review, which evaluated the most commonly produced species. In its approach to shellfish culture the United States of America was consistent with the remainder of Europe, in not appearing to require any form of environmental impact assessment for this culture practice.

Within freshwater culture, which is predominated by channel catfish, and despite the lack of EIA, the permit procedure appears on the surface to be robust. This is in part because the United States of America has, at federal level, explicit water quality requirements that need to be adhered to by the aquaculture industry, through the NPDES permit process. There is a high level of data and guidance available through the USEPA Web site, and importantly, examples of the permits issued were available for evaluation. This showed that explicit site specific monitoring requirements were identified in the license, along with advice on how and when this should be carried out.

What is not clear from this review of the implementation of EIA within aquaculture development is the effect the Best Management Practice has had on the need for EIA in the United States of America. BMP means there are some fairly well defined practices that can be employed, in a similar way to Codes of Practice (CoPs) issued by European, pan-European and national trade organizations. However, the BMP procedures would appear to have a slightly higher status than CoP in Europe, because they seem to be equally embedded within the governmental (be that national, state or local) requirements. Thus, with the requirement to conduct specific practices, which have been determined to reduce environmental impact, endorsed by government departments, the need for EIA in the United States of America may be overcome.

This may be true in part. However, what has been shown is that BMP procedures in themselves do not provide for an evaluation of the impact of an aquaculture development on the environment. Clearly certain states, such as California, which in 2006 appeared to be the first state to implement the need for a full evaluation through a process of EIA, believe there is a need for a fuller investigation of the impacts of aquaculture. This means that future development of aquaculture within the United States of America might involve formal evaluation through an EIA process.

Within Canada, in contrast, there is a need to evaluate the impacts of aquaculture development, through the EIA process. This applies equally to finfish culture (which is dominated by salmon) and shellfish culture, unlike both the United States of America and Europe. Canada has a set of comprehensive EIA requirements and has produced material specific to this subject, which lays out the requirements in significant detail. The experience of Nova Scotia has also shown that it is important that a consistently collected body of data is available, over a wide area and consisting of a range of aquaculture systems. It provides the possibility that future decisions on potential environmental impacts can be better made with less data in the EIA.

General comments

Overall the review has shown that the level of EIA and monitoring within Europe and North America is both varied and inconsistent, where it is carried out. This is not only in the time taken for the process to reach completion, but also in the variable volume and type of data that needs to be evaluated both during the EIA phase and the post-development monitoring phase.

The collection of data is expensive and hence it needs to be targeted at providing the information necessary to inform the assessment, to identify an impact, to develop a mitigation strategy as part of the EIA and to manage and monitor the impacts that are deemed significant after development has been approved. Such aspects should be identified as early as practicable within the EIA process in order to identify specifically those elements and impacts requiring investigation. Such a strategy will also inform and enable optimisation of the subsequent monitoring plan.

Thus for any aquaculture development, the following general points need to be considered and agreed as part of any EIA procedure and environmental monitoring plan:

- the major impacts to be evaluated and monitored;
- the objectives of monitoring and data requirements;
- the use of the information collected;
- the response in both the EIA and monitoring procedures to unanticipated or greater than predicted impacts;
- the measures for public reporting and involvement;
- the need for a regular review of the monitoring plan, to ensure that the relevant information is being collected;
- the need for monitoring requirements to focus on the significant impacts predicted in the EIA report, taking account of:
  - the environmental values to be safeguarded;
  - the magnitude of each potential impact;
  - the risk or probability of each impact occurring.

Papoutsoglou (2000) noted that generally within an EIA process for the development of aquaculture sites, the closer the links between the regulatory system and actual practices at aquaculture (fish) farms, the less objections, difficulties and misunderstandings occur in the interpretation of the EIS and management plan. This aids rather than hinders the overall development of the aquaculture industry. Papoutsoglou (2000) noted too that the continuous appearance of new "legislation" orders, which added to bureaucratic complexities too (in Greece, but also in many other countries), means that it had become difficult to fully meet the demands of any regulatory system. Such changes are compounded by the diversity of each aquaculture development in terms of the sites, species, feeding systems, production system and management systems in use.

In Greece and elsewhere, the main problems with environmental legislation (Papoutsoglou, 2000) are associated with:

- insufficient "contact" between the marine aquaculture industry and society;
- insufficient understanding of the philosophy of aquatic environment protection, since the same conflicts between most farmers (mainly those of marine cage farms) and the local communities arise time and again and are rarely entirely resolved;
- insufficient coastal zone planning, together with the absence of designated marine aquaculture areas, leading to an almost continuous argument between neighbouring land users (including tourism and local authorities);
- insufficient control of the operational standards of farms;
- unstable local (or other) market conditions.

There remains considerable scope for improvement in the legislative framework affecting aquaculture. In Greece, the Netherlands and Italy, for example, the introduction of a central "Aquaculture Policy" could greatly assist the development of the industry in relation to other uses of the coastal zone. Provided there is sufficient central regulation with appropriate definitions and body of supportive and accessible (published) advice (such as in Canada), then it would appear reasonable that the responsibility for the review of EIAs, the leasing of sites and the licensing of operations be delegated to local government control. The important aspects remain the consistency with which the "rules" are applied, the involvement of all appropriate stakeholders and the confidence that transparency is ensured in any and all decisions made.

Effectiveness

INTRODUCTION

Due to research efforts and existing EIA and monitoring requirements and practices in Europe, Canada and the United States of America for marine fish farms, the gross effects of fish farming on sediments are relatively well understood. The impact on the sea bed is the most obvious pollution effect from marine fish farms and measures of this effect are the main method of regulating and controlling fish farms such that the local environment is not overwhelmed. Most fish farms are regulated in this respect in terms of their size or the maximum biomass of fish permissible. Other criteria such as mitigation technologies are not taken into account, though the maximum biomass allowed is often calculated on the basis of environmental factors, i.e. hydrodynamic conditions. In freshwaters, water quality parameters are used as a measure of impact, i.e. levels of phosphorus or productivity, normally denoted as amount of chlorophyll, in lakes and BOD for flowing waters in rivers. These are well monitored and can be readily measured for comparison with quality standards set by the regulator.

However, the EIA process reviews more environmental information than simply parameters used to assess biological and chemical impacts. For example, Environmental Impact Statements (EIS), which are the documents/reports produced as a result of the EIA process, include other risks and impacts such as socio-economic impacts (and benefits) and visual impact on landscape character. Both are becoming more important in the EIA process for aquaculture development, e.g. approximately 32 percent of applications for new marine fish farms in Scotland between 1999 and 2004 were rejected on the basis of visual impacts alone (Hambrey and Southall, 2005). These impacts, biological, chemical and visual, may be estimated prior to the beginning of the development using predictive models. Again, this would normally be part of the EIA process.

TECHNICAL APPROPRIATENESS IN EUROPEAN COUNTRIES

EIA is regarded as the environmental assessment tool traditionally used in Europe for the prediction of likely impacts from new aquaculture developments, rather than as a mechanism of assessing its environmental or socio-economic sustainability. This is unfortunate as the EIA could be used as an excellent tool for doing just this if the regulatory process was not being done on a project-by-project or site-by-site basis as it is at present. Consideration of the wider ecosystem including all inputs and socio-economic implications would be both beneficial and allow a wider assessment than now. As described by Becker and Jahn (1999) *"...sustainability is less a matter of particular undertakings, than of industry and society-wide decisions, trends and patterns. EIA tends to focus on the former."*

Previous research suggests that a number of factors influence the quality of EIA reports. These include the date of the EIA report, the nature of legal requirements for EIA, the experience of the proponent, the consultant and the competent authority, the existence of scoping, the length and cost of the EIA report and the nature and size of the project (see Barker and Wood, 1999). In Scotland, this was shown to be particularly true for aquaculture in terms to the variation in implementation of regulation and the quality of the EIA reporting (RSP Group PLC, 2007).

Although the study by Barker and Wood (1999) was carried out on general EIA reports and not those specific to aquaculture, it highlighted the point that the quality of EIAs and EISs varies greatly between EU member states, despite being bound to the same EU EIA Directive (97/11/EC). They also found that the EIA procedure exhibits considerable diversity both in terms of methodology and legislative framework between different countries.

As reviewed in Section 2, the monitoring undertaken for aquaculture throughout the EU is varied, both in terms of requirements and effectiveness in their use. The requirements are based on a number of EU Directives (see Section 2), which are incorporated into individual country legislation. However, this has been done to varying degrees, but has also had historical legislation to "contend" with. Often meaning that far from simplifying requirements for environmental monitoring for aquaculture developments there has sometimes been a complication of these regulations. Examples of this would be Italy and Greece. Possibly when this EU regulation is fully implemented the legislation may simplify.

Where specified, the monitoring requirements are of a similar nature, samples of water and sediments are taken from the proximity of the fish farm or discharge point and these are then compared with Environmental Quality Standards, which are specific to the type of aquaculture and/or the country using them, but are still largely based on the same scientific data used for their formulation and therefore similar in nature. In consequence, the effectiveness of environmental regulation in European countries is not dependent on the quality standards used or the monitoring methods employed. It is dependent on the variability of their implementation within legislation.

There is little information on specific effectiveness of implementation of the monitoring, as aquaculture is only one of a number of effluent discharges contributing to environmental impacts and using up the assimilative capacity of the aquatic environment, see Section 3.4. Exceptions to this are almost entirely in relation to salmon aquaculture where reviews are undertaken on data acquired through fish farm monitoring (SEPA, 2005) and specific monitoring studies to look further at wider environmental impacts, e.g. plankton blooms (Tett and Edwards, 2002), or medicants (SAMS, 2005). Both studies showed there are no significant environmental impacts that could be attributed to salmon farming in Scotland and thus the present level of monitoring and regulation is sufficient and effective.

Czech Republic

There are several factors in the Czech Republic which make the EIA procedures and practices outlined above ineffective. There is enormous difficulty determining the extent of ownership of ponds used for fish culture. This makes the implementation and policing of regulation very difficult and therefore the EIA procedure is unlikely to be implemented fully by the fish farmers. This difficulty is largely due to the state-ownership of aquaculture prior to 1993 and its progressive and poorly documented privatisation between 1993 and 1995 (Globefish, 2008). There is no evidence of the need to have done an EIA before privatisation. Currently "Rybarske Sdruzeni Ceske Budejovice" (Czech Fish Farmer Association) maintains contact with up to 110 owners/organizations that produce the majority of the fish produced (Globefish, 2008).

The use of EIA may increase in the future as larger farms are developed, better documentation is kept and as species are cultured more intensively, although the national strategic plan aims at maintaining, rather than increasing, present levels of aquaculture and fisheries sector until 2013. This future development may also be limited due to the required investment within the fish farming industry. It is generally accepted that many ponds are degraded and in bad repair, through extended under-investment. Investment and structural changes to repair ponds, or rehabilitate facilities, funded largely through the EFF and FIFG may actually limit increase in fish production and thus the need for future EIAs.

At present there is no apparent assessment or environmental monitoring required to record the post-development impacts, including that of pond culture, after privatization in 1993 (Braniš and Christopoulos, 2005), though there may be changes to this in the near future with the implementation of the Water Framework Directive (EU Directive 2000/60/EC) through the State Environmental Policy (Ministry of the Environment of the Czech Republic, 2004). This policy does not specifically mention aquaculture and therefore does not develop definitive monitoring strategies for the fish farming industry. However, as this has not taken effect there is no opportunity as yet to comment on its effectiveness.

France

A review of the EIA requirements and practice for aquaculture in France reveals an incredibly complex and in some ways archaic system of regulation in freshwaters (Madec, 2003). In marine systems there is variable regulation required with the most commonly cultured species, bivalve molluscs, not being subject to rigorous legislation at all due to legal differences existing between fish and shellfish. Shellfish only have legislation based on designated areas for culture using the EC Shellfish Directive (79/923/EEC) classification system (European Commission, 1979). Therefore the only monitoring requirements from this industry are for biotoxins and pathogenic bacteria.

The complexities of the system for freshwater fish farms and the time taken for completion of the process (up to two years) decreases the effectiveness of the implementation of the EIA particularly for smaller operators who cannot necessarily plan for two years ahead and gives little incentive. However, the stringent water quality parameters are likely to mean that, if implemented, the environment is unlikely to undergo significant impacts during farm production.

Once permission is given for development, an overall review is only mandatory after 30 years in freshwater systems and 35 years in marine systems, though monitoring results and comparison with the quality standards may result in short-term review of farming practice in consultation with the stakeholders. This may mean that there may not be rigorous safeguarding of environmental quality by this process, but there is no information available on the legislative power of the regulators in terms of sanctions and actions that can be taken by them.

This system in France requires a number of efficiency measures to make it more effective, which may include :

(i) an urgent simplification of the legislation and application process;
(ii) better documentation and recording of production sites. The diversity of groups concerned in the application means that there is no central records system. This may happen if the system is simplified; and
(iii) more defined legislative power in terms of failure to comply with legislative standards. This should be initially agreed with all stakeholders.

Greece

According to Barker and Wood (1999), EIA legislation (since 1990) appears to have had a beneficial influence on the quality of EIA reports in Greece. Again the experience of the consultants and decision-making authority involved in the EIA process caused large variations in the quality of Environmental Statements in Greece.

The legislative framework for the aquaculture sector in Greece refers to fishery exploitation and the management of aquatic resources. It does not cover the complete administration of the coastal zone, land or freshwater areas, which are under the purview of other ministries. The existence of a number of regulations per ministry for the use of these various areas, together with the lack of harmonized land planning and the lack of priorities given to the use of common resources, has caused delays and rejections of applications for aquaculture units (Klaoudatos, 2001).

For the establishment of aquaculture units, expert opinions are required from the jointly competent bodies (ministries) and licenses to operate are issued by them. Thus the use of common resources should be regulated from the beginning and disputes or problems could be avoided. In many instances, problems are discussed at the prefectural level, with the participation of local communities, who are given the opportunity to express their opinion about the aquaculture development. If granted, the competent body then issues the license that ensures the unit is operated properly. The major problems arising in Greece are due to the non-application, on the part of the governing body, of the operational rules and procedures. These are provided by the relevant authority and concern all activities which use common resources. In this particular circumstance, when examining issues or problems of the aquaculture sector, informal (*ad hoc*) committees are set up by the Ministry of Agriculture, in which aquaculture experts from the state (ministries, institutes, universities) and private sectors meet to help solve problems that arise (Klaoudatos, 2001).

Generally the strategies used by the Greek government authorities to promote awareness about the sustainable use of the marine environment are (from Klaoudatos, 2001):

(i) to create mechanisms in order to control environmental impact assessment (EIA) of aquaculture;
(ii) to encourage co-operation between aquaculture producers and national research centres;
(iii) to improve responsibility among all the users of the marine environment;
(iv) to install systems that permanently record abiotic water parameters.

Responsible services of the Ministries of Agriculture and Environment, Land Planning and Public Works, the services of the prefectural authorities and the national research centres keep a continuous monitoring record of the environmental impacts of aquaculture. Systems, which the State has installed for certain cultures (shellfish, cyprinids, salmonids), permanently record the abiotic water parameters, so that farmers are continuously informed and remain compliant with the limits set in the legislation for the protection of the environment. At the same time, the Ministry of Environment monitors the waters of all coastal areas of the country (based on the Directives of the European Union) in their specialist laboratories. However, the monitoring mechanisms used by the government authorities are not deemed to fully meet the environmental requirements and an upgrade of the control system is in progress (Klaoudatos, 2001).

The compliance of aquaculture farmers with environmental legislation requires (apart from the threat of sanctions being imposed) a conscientious acceptance of the necessity for the protection of the environment. The future plans and strategies for the perpetual use of natural resources requires thorough knowledge and long lasting co-operation between all users of the marine and coastal environment. However it is unlikely that this ideal picture will be achieved in the near future. In Greece for example, the determination of zones for agriculture, aquaculture, industry and tourism has not been concluded. This creates problems, as the procedure of determining zones of use will help solve a lot of existing problems in the governance of an expanding aquaculture industry (Klaoudatos 2001). The intention is to identify the possible adverse impacts of an aquaculture farm, prior to its construction and granting of an operational license.

In Greece, producers must provide statistical data for the production process of their fish farms and for the physicochemical parameters of the marine environment. At a national level, there is an obligation for the producers to provide statistical data, but problems arise in many instances, especially in connection with the collection and comparability of the data. The data should be collected and provided through a network so as to be available to all users. The dissemination of research results is not considered satisfactory in Greece due to the lack of a relevant information network. The sector needs more seminars, meetings and aquaculture exhibitions, as well as special publications and booklets referring to the methods for administering aquaculture units. Farmers should have continuous information to update them about new technology and the damage which thoughtless use of the marine environment could cause (Klaoudatos, 2001).

In addition, the methodology for an EIA study must be clarified in order to have comparable results. It is extremely difficult to monitor the effects of the aquaculture industry on the marine environment as the ecosystem and management differs from one farm to another. It is therefore extremely important to assign indicators to the various ecosystems and to continuously monitor them in order to intervene in the case of environmental degradation (Klaoudatos 2001).

A study focusing specifically on the performance of the EIA system in Greece (Androulidakis and Karakassis, 2006) concluded that the standard of EIAs was generally poor and they did not address the issues outlined within the scoping exercise. The inference from this is that poor implementation of the EIA process would lead to inappropriate siting of developments and if this was instigated in the same way for aquaculture it could undermine effective environmental management.

Hungary

The political transition of Hungary in the 1990s caused a number of issues related to the privatisation of commercial activities. These issues included lack of record-keeping and consistent environmental regulation, resulting in a general deterioration of water quality on fishponds and adjacent rivers and watercourses. This has lead to the development of the Hungarian Agricultural and Rural Development Operation Programme. Accession to the EU has added to these issues in the requirement for implementation of environmental directives and regulation. In addition, considerable funding is being provided towards the development of a strategy for sustainable aquaculture (CONSENSUS, 2005a).

However, there is no specific water monitoring or EIA programme specified within the Agricultural and Rural Development Operation Programme and therefore the state of the environment is largely left under the control of the user. Present EIA and regulatory monitoring in Hungary is ineffective. Implementation of the EU Directives and the additional funding invested should lead to considerable infrastructural and environmental improvements over the next five to ten years.

Italy

The fact that there is no national legislative framework for environmental impact assessment in Italy (in relation to EU Directive 85/337 EEC), has contributed to the poor involvement of the public in the EIA process and the effectiveness of environmental assessment as a whole. Although this is a generalised observation by Del Furia and Wallace-Jones (2000), it is related to the Italian aquaculture industry, as farms over 5 ha are subject to EIA under guidelines set by regional authorities. Potential obstacles to the development and approval of an EIA framework law are the inefficiency of the legal system, the lack of horizontal communication channels and coordination (between regions) and an unwillingness to accept a coherent law by the autonomous provinces and regions.

Other important steps to be taken in encouraging EIA culture in Italy are to develop best-practice guidelines and procedures for developers (for all types of project, including aquaculture), administrators and citizens. Strengthening of the Italian EIA network could take place by dedicating further resources to the EIA centre in Milan, or the establishment of another independent institute that focuses on collating EIA skills and supports all of the factors involved in establishing standards and implementing EIA. This is essential in Italy, as there is a strong possibility that approval of a framework law could take a long time (Del Furia and Wallace-Jones, 2000).

Netherlands

Aquaculture in the Netherlands is dominated by culture of mussels, which, though subject to biweekly monitoring for the presence of pathogenic bacteria and biotoxins, are not specifically subject to EIA and environmental quality regulations. In addition, there is a moratorium on new shellfish production sites. Authorization of inland aquaculture is only subject to permits required for normal planning in terms of environmental protection and land-use, which are not specific to aquaculture.

There are no specific EIA requirements and legislation specific to aquaculture in Dutch Law and therefore it is difficult to judge the effectiveness of the limited regulations specifically for aquaculture. Review of the available information suggests that aquaculture development is significantly limited in coastal systems and is minimal for inland systems in the Netherlands. Therefore present aquaculture developments are likely to have only limited environmental impacts.

Poland

Poland faces environmental challenges at present within the aquaculture industry, as there is a net increase in production of inland fish through higher levels of trout production and stabilisation of carp production. In Poland aquaculture is defined as a Group 2 activity under the EU EIA Directive and therefore may require an EIA to be performed as part of the developmental process. The production criteria specified as the threshold requirement for an EIA to be performed under these circumstances are in excess of the mostly small-scale levels of fish produced per farm and therefore EIAs are largely not actually required or undertaken. There is little evidence then that historically the EIA process in Poland has had any effectiveness in reducing the environmental effects and contributing to the environmental management of aquaculture.

With the accession to the EU, however, Poland has developed a National Strategy for the Development of Fisheries to be implemented between 2007 and 2013. In addition, there is professionalism and a well developed education system, including training at vocational, secondary and university levels, for fisheries and aquaculture in Poland. This may mean that the benefits of the EIA process in the management of fish farming are likely to be implemented within this sector in the future.

The most dynamic aquaculture sector within Poland is the production of trout for stocking and restocking of rivers and lakes. This has its own environmental implications, especially on the genetic impacts of wild stocks of fish and potential destruction of habitats for native fish. The restocking of rivers for trout is due to the "poor environmental regulation" and "construction of dams" (Wenne *et al.*, 2000, cited in Was and Wenne, 2004). The restocking of these rivers with single populations of hatchery-derived fish has lead to a lack of genetic variability between river systems (Was and Wenne, 2004), which probably would have been highlighted under an EIA process if carried out.

Spain

The range of experience of the consultants compiling the EIA, and the experience of the authority making decisions on the basis of the EIA, caused the most variation in the quality of environmental statements produced in Spain. Additionally, shorter EIA reports were often of lower quality.

Trout

During the development of the trout farming sector in Spain, serious pollution problems related to external sources (namely pesticides and fertilisers) occurred. This resulted in the closure of many fish farms that were not located in the upper reaches of rivers. Trout require clean well-oxygenated water and hence they have been a permanent indicator of river water quality. Historically, major pollution problems in rivers and changes in river characteristics have been due to heavy industry and recent efforts by the environment authorities to improve river conditions, have not been effective (Torrent Bravo and Sanchez Montañés, 2001).

Due to the above situation and the lack of legal instruments, the existing Environmental Authorities developed different laws and regulations, sometimes very quickly and also very restrictively, which lead to the owners of trout farms having to pay very large sums of money. In addition, there was also a distinct lack of effort by the Environmental Authorities to maintain or improve the river water quality used by trout farms (Torrent Bravo and Sanchez Montañés, 2001).

Use of the different laws and regulations combined with the knowledge that many of the rivers had poor water quality has lead to the closure of many freshwater facilities (Torrent Bravo and Sanchez Montañés, 2001). The farmers pay for the amount of water they use i.e. the difference between the inlet and the outlet. However, there are some limits for the dry season where the farmers can use only a predetermined water flow from the river which is called "the ecological water flow". Nowadays, after several decades of conflict between fish farms and the authorities responsible for water management, the situation is becoming reasonable. However, new environmental regulations arise and are a permanent threat to fish farms, as they often focus on specific small effluents with a high pollutant load and not on the high volume effluent with little organic solids released from a fish farm (Torrent Bravo and Sanchez Montañés, 2001).

Turbot

The environmental regulation for turbot farming has been developed over the past decades and has faced similar problems to those already encountered by trout farms. Also due to the lack of previous planning by the relevant authorities, problems concerning environmental regulation and monitoring often have to be solved as they arise. The criteria used to determine the quality of wastewater from turbot farms have been taken from those used for domestic and industrial effluents, thus regulations have not focused specifically on aquaculture activity and this particular type of effluent (Torrent Bravo and Sanchez Montañés, 2001).

Cage farming

In relation to existing environmental regulations, the situation has also been similar to trout farms. At the beginning of the 1990s, cage farming was not carried out on a large enough scale to have specific regulations. Thus the sector has been affected by a large number of different regulations designed for other types of activities (Torrent Bravo and Sanchez Montañés, 2001). In terms of aquaculture, the regulations do not clearly define the impacts generated, any parameters that demonstrate a farm is in operation, are often given a high relevance.

According to Torrent Bravo and Sanchez Montañés (2001) it has been more convenient for the regulatory authorities to relate the impact of aquaculture farms with the impacts of other activities, i.e. fishing, the release of untreated effluents or the construction of harbours. Fish farmers are concerned that more pressure is placed on their sector than on others. Spanish farmers also believe that only the negative aspects of fish farming are used as indicators when environmental monitoring programmes are designed by the regulatory authorities. The management practices of a farm are not monitored and farmers believe this should play a vital part when assessing environmental impacts.

Finally, as there are no clearly defined criteria or objectives to evaluate and track the impacts of aquaculture, confusion has been created leading to the situation that each office for different Spanish regions uses different criteria. This has caused serious problems, as the published environmental reports are being used politically and in some cases are creating confusion, especially to the public. It is public opinion that can seriously deter the development of aquaculture both on and off Spanish coasts (Torrent Bravo and Sanchez Montañés, 2001). However, the production sector, together with the administration, has taken several actions to progress environmental regulation within aquaculture. The first has been the production of the "White Book of Spanish Aquaculture", which provides a comprehensive review of the sector with a whole chapter dedicated to aquaculture and the environment. In addition, the production sector through its Association of Marine Aquaculture Producers (APROMAR), has agreed to follow a Code of Conduct developed by the Federation of European Aquaculture Producers (FEAP).

Torrent Bravo and Sanchez Montañés (2001) conclude that whilst Spain is developing its environmental laws, the development of aquaculture is suffering, due to new environmental laws, where the activity is not considered specifically. Aquaculture permits are issued with many imprecise environmental requirements that are creating uncertainty among new investors. The environmental impact reports are not precisely designed for aquaculture purposes, which creates uncertainties and give rise to doubts that the regional authorities are generally not experts in aquaculture.

A TECAM seminar during which regulators, researchers and producers discussed environmental impact assessment in Mediterranean aquaculture, gave an insight into the effectiveness of the EIA process for aquaculture in Spain (Uriarte *et al.*, 2001). Regulators and scientists commented that though complex the EIA requirements were reasonable, but that there was a lack of information on aspects such as the quality and quantity of pollutants generated, the ratios of feed and biomass, water quality and disease . It was argued that provision of this information should be fundamental and straightforward. However, a producer disagreed commenting that the guidelines on data provision and regulations for aquaculture in Spain were very strict and "*if they were followed there would be no aquaculture farms*". While these points of view reflect the different interests of the people involved, it highlights a basic problem in communication and education of the need for the EIA process and monitoring. At the same time it highlights the need to obtain stakeholder input into demystifying or "de-complicating" the regulatory process.

Turkey

Until the early 2000s, the marine aquaculture sector in Turkey has enjoyed full public support, cheap labour and a lack of strict environmental and marketing regulations and thus has developed rapidly. However, rapid development on the Aegean coast has created opposition from the tourism sector, local people, holiday homeowners, environmental NGOs and small-scale fishermen, and has also led to new environmental requirements (Okumus, 2007).

It is essential that the location, the aquaculture system (cage, hatchery, tank or pond) size and its licence status is reviewed regularly by the General Directorate of Agricultural Production and Development (GDAPD), preferably each year. Aerial surveillance may be useful for rapidly compiling information on the number, size and location of installations. This information should be held on a database and made available for use by the appropriate authorities, consultative committees and inter-ministerial working parties (Deniz, 2001). It is also important to encourage awareness of environmental protection and the potential impacts and benefits of different types of aquaculture upon the coastal environment, within the aquaculture industry and other interested parties. Aquaculture registration must be streamlined and tailored to operate within each relevant ministry and between ministries. Environmental issues demanding legislation and enforcement include the control of disease, transfer of species to new or different sites, control of chemicals, farm location and waste disposal. The development of a site selection strategy should take into account at least: depth, location, farm size and type, proximity to other developments and the species to be farmed (Deniz, 2001).

Co-operation between MARA and the Ministries of Environment and Culture must also take place. The development of a plan could allow aquaculture to progress without significant impact, by including (Deniz, 2001):

1. the identification of sensitive ecosystems, habitats, endangered species and poor sites (too shallow, slow currents) i.e. where aquaculture or any other development must not take place under any circumstances; such as turtle nesting sites/protected bird-nesting sites;
2. the identification of less sensitive sites outside these areas, which forms a 1km buffer zone where no aquaculture can take place;
3. aquaculture projects (which can take place outside the 1km buffer) can then be identified. Assessment of licence applications and EIAs for larger schemes should be more rigorous in these outer zones than in normal coastal areas. Such applications and EIAs should pay particular attention to the designated features of the protected area.

Deniz (2001) also suggests it is necessary to simplify but continue to enforce leasing procedures for aquaculture sites, to prevent developers from reclaiming large stretches of shoreline for construction. This requires direct liaison between GADP and the Ministry of Forestry and the Ministry of Tourism.

The development of a rapid and regular consultation process within Turkey is needed to assess applications for aquaculture licences with input from statutory consultees including MARA, Ministries of Environment, Reconstruction, Culture and Tourism, navigation and military interests. This should be achieved through regular meetings (every three months) and adherence to a coastal planning policy that has been agreed by all parties in advance. A system must also be in place for public consultation on developments prior to building, though guidelines should be flexible and based on evolving environmental and technical knowledge. The MARA should also liaise with the Ministry of Tourism to determine the number of existing aquaculture operations sited illegally in tourism areas, as well as their impact on the environment and landscape. If they are acceptable, they should apply for and rapidly receive a license to operate, if they are unacceptable then they should be forced to cease operation and remove all equipment. Deniz (2001) also suggests that the development of an aquaculture fraternity through producer organizations is needed to identify the needs and priorities of the aquaculture industry in Turkey. Legislation should also be strengthened in order to protect sensitive species, habitats and special sites related to the coastal environment. It is recommended that special protection areas and national parks be used as the central mechanism in this context.

Integrated coastal zone management

At present, coastal management is fragmented in Turkey, with overlapping responsibilities. Communication and coordination are lacking and there is a need for integration and harmonisation of related policies and regulations. Recent environmental national regulation (*Law No 5491* dated 26 April 2006 amending the Environmental Law) is intended to exclude marine cages from enclosed bays, but the definitions in the bill are considered somewhat vague (Okumus, 2007). In Turkey there is an urgent need to take a holistic approach when managing the coastal zone. This requires reliable, long term and transparent data, cooperation (of all stakeholders), an administrative structure (including ministries or departments of environment, fisheries, maritime affairs, culture, tourism, agriculture, forestry, transport, *etc.*) and infrastructure. Good coastal zone planning requires the drafting of strategic integrated management plans rather than taking isolated actions and amending them on an *ad hoc* basis. A forward thinking ICZM plan might also try to bring opposing sectors together rather than segregating them.

United Kingdom

The experience of the participants in the EIA process (the proponent, the consultants compiling the EIA and the competent authority making decisions of the basis of the information contained within the EIA) was found to be the single most important variable in explaining variations in the quality of Environmental Statements in the United Kingdom. In addition, scoping, and particularly the involvement of the public, also appeared to improve EIA report quality in the UK (Barker and Wood, 1999). In addition, although there is no apparent relationship between the length of EIA reports and their quality, it appears that short EIA reports are frequently of "unsatisfactory" quality. The generally positive relationship between EIA report length and quality was confirmed by the EIA reports studied from the UK (Barker and Wood, 1999)

A detailed study on Scottish environmental impact statements for cage culture in coastal waters primarily for salmon, but also for marine culture of Atlantic cod (RPS Group PLC, 2007) showed that there was a range of quality across those reviewed and the technical assessment of data within the Environmental Impact Statements (EISs) tended to be inconsistent. In general it was found that consultation and scoping were not addressed adequately and thus not focusing on the key impacts from the outset. Scoping for the Environmental Statements reviewed (and all others) was performed by statutory regulatory bodies in a non-standard format (RPS Group PLC, 2007). This causes a potential conflict in that many of the EISs reviewed where written to follow EU Directive guidelines (see Annex 1), but were trying to answer issues highlighted by a non-standard scoping approach, not carried out as a separate study for individual EIAs. This has the potential for the Environmental Statement produced to both lack information and lose effectiveness in its implementation and relevance. Introduction of a simpler and more streamlined procedure for EIA, such as that proposed by RPS Group PLC (2007; see Annex 4 to this paper) would significantly improve consistency between scoping and the final Environmental Statement and thus its effectiveness as part of the aquaculture planning process. One specific problem that is poorly addressed by both regulation and the EIA are the issues associated with cultured fish escaping into the marine environment. This is a problem that can only be addressed through either relocation of sites or by the use of improved technology. Generally in this regard the consideration of the impacts and mitigation issues of escapes were poorly dealt with during the EIA process.

The procedures for the monitoring of coastal aquaculture in the UK are largely based on salmon, but the well defined monitoring approach implemented by SEPA has generally lead to an improvement, or no degradation in environmental quality (SEPA, 2005) even though cage farming has increased.

Inland aquaculture using waters from rivers or lakes again appears to be effective in terms of minimizing environmental impacts. Strict measures are implemented to prevent changes in the trophic status of waterbodies and thus to significantly increase environmental quality within rivers. There are few incidences of significant impact on rivers and lakes due solely to aquaculture and thus we can conclude that the regulatory system is effective. Stakeholders, however, argue that the quality standards used for regulation are too restrictive and that the true carrying capacity, in terms of assimilation of nutrients within lake and rivers, is not used effectively.

TECHNICAL APPROPRIATENESS IN NORTH AMERICA

Canada

There is little to no documented information available on the technical appropriateness of the EIA process as it is applied to aquaculture developments for non-marine salmonid production in Canada, nor more generally on the effectiveness of the EIA and monitoring processes and procedures. It is perhaps explicit that at least part of the

Canadian EIA process for aquaculture is effective as controls and changes are made as a result of statutory monitoring of aquaculture developments, as defined by the federal Department of Fisheries and Oceans Canada (DFO) (see Smith *et al*., 2002). The DFO (2004) indicate as much citing that "In combination with ongoing federal and provincial environmental monitoring programmes, aquaculture projects being subjected to environmental assessments ensure that no unforeseen, significant negative consequences on the environment arise from aquaculture operations". However, there appears to be a suggestion (DFO, 2004), that the increased level of providing information and maintaining the level of detail required in the regulatory process (which would include environmental impact assessment) is costing significant time and effort and is seen as one of the reasons the aquaculture industry has not developed to its full potential.

Over time the use of EIA for aquaculture in Canada has developed, changed and by assumption become more appropriate to the situations being evaluated. Curtis (2004) refers well to the outcomes from the MARAQUA project (Read *et al.,* 2001; Fernandes *et al.,* 2000) and identifies the need for best practice within an EIA strategy to provide a well structured and informative planning evaluation tool for aquaculture. Whilst identifying the overarching guiding principles from organizations such as the United Nations Environment Program (UNEP; Sadler and McCabe, 2002) and the International Association for Impact Assessment (IAIA, 1999), the development of best practice for aquaculture is an iterative process, which the Canadians entered and are continuing to develop.

In more general terms the Canadian government has undertaken to align federal and provincial requirements of EIA through a series of government/province environmental assessment agreements (CEAA, 2008). It is hoped that this will improve the balance of government and provincial legislative requirements for EIA, including for aquaculture, although again it has not been possible to determine how appropriate this has been in practice. In principle the integration of requirements will make the process more efficient. Also, recognising the high cost and effort required, part of the instigation of tighter and more appropriate controls is the use of so-called Class Screening Reports. Class Screening Reports aims to streamline the EIA process of certain categories of project. Such reports are applied only to projects that have similar knowledge bases accumulated through past environmental assessments (Canada Transport Canada, 2007) and where baseline data and impacts are sufficiently well known. One such case is suspended oyster culture in New Brunswick, where the majority of proponents use similar methodologies and infrastructure and management. It is not, however, applied to other forms of oyster culture. Canada Transport Canada (2007) outlines the thinking and requirements of this but as yet its appropriateness and effectiveness has not been critically evaluated. There is an inherent assumption that using this concept will streamline the assessment process but as yet without the supporting information to show that it has.

It is generally accepted that in order for the EIA process to be credible and to fulfil the requirement of enabling good and sustainable control of aquaculture development, the EIA process must be fair, objective and comprehensive (Sadar, 2004). The Canadian government now ensures good public participation, the use of competent professional advice and use the best available scientific information and data through the Canadian Environmental Assessment Act 2003. However, as Sadar (2004) points out, there are key limitations, which include insufficient baseline data about the biophysical and social environments and time and resource constraints for completing the EIA process, which currently act to make the EIA process less robust than it could be. Clearly, as outlined above, the iterative development of a streamlined and appropriate EIA procedure and practice remains a high priority for Canadian aquaculture development.

In western Canada, the Legislative Assembly of British Columbia commissioned a Special Committee on Sustainable Aquaculture to review the impacts and management of aquaculture in British Columbia. The report has recently been published (British Columbia, Legislative Assembly, 2007). They made a number of recommendations in relation to finfish (salmon and cod) culture and shellfish culture on the basis of their environmental impact and related assessment. Central to these recommendations is moving to ocean-based closed containment systems within the next three years. Much of this development is to be funded by the local government. In addition, incentives will be given to the aquaculture industry to facilitate this transition. There should be no new finfish species introduced for ocean-based aquaculture other than salmon. Shellfish aquaculture should be encouraged and expanded within inshore waters in areas that are designated to minimize competition with other coastal resource users. A code of practice should also be adopted to respect the interests of other coastal stakeholders, including First Nations, residential communities, small shellfish operators, tourism and other businesses and recreational users. In addition, it is envisaged that the Ministry of the Environment should increase environmental regulation to minimize release or debris and waste from shellfish operations. Thus, on the basis of results from existing environmental regulation, there is the perception in western Canada that inshore waters should be primarily used for shellfish production. Graham, the DFO's then Assistant Deputy Minister, at the Aquaculture Canada 2003 meeting (Graham, 2003) recognised that there was a need for all governmental agencies to synchronize their information requirements for the review of marine finfish and shellfish aquaculture applications, and this is now being done (CEAA, 2008), although its impact is yet to be fully realized. More recently, Heaslip (2008) commented that there is still some way to go in the practice of monitoring fish farm wastes in British Columbia. He suggested that the monitoring of these wastes should include far field monitoring (at a considerable distance form the fish farm) to include impacts on clam-harvesting and traditional fishing, and to "broaden and integrate" the experience and practices of First Nation peoples. The integration process between science and local knowledge though is acknowledged as very difficult, especially in presenting this in a manner which is readily understandable to decision-makers (Berkes *et al*., 2007).

By continuing to tackle and develop its strategy, the Canadian government authorities can advance the aquaculture industry's own capacity to produce dependable environmental assessment plans. This along with the management outlined above should increase the government decision-making efficiency and thus reduce the expenditure associated with the preparation of aquaculture applications. That said, full, creditable and critical analysis of the appropriate use of EIA for aquaculture development in Canada remains scarce.

United States of America

There is no documented information found specifically on the effectiveness or technical appropriateness of EIA and environmental monitoring in aquaculture in the United States of America. However, there seems to be an environment of implementation of new regulations for regulating environmental impacts (e.g. report of the Marine Aquaculture Task Force; 2007). But this again does not give specific measures for environmental assessment but instead suggests a mechanism of federal governance.

USE OF GENERATED DATA – THE EXAMPLE OF OSPAR/RID

The recent data report of the OSPAR study on Riverine Inputs and Direct Discharges (RID) includes information on the discharges of nitrogen and phosphorus from aquaculture plants at national levels (OSPAR, 2006). Estimates of the nutrient discharges are based on data from the relevant effluent control programme of each OSPAR member state.. The collected data on nutrient (nitrogen, phosphorus) discharges from aquaculture operations indicate that aquaculture activities in Norway and Scotland do contribute to some extent to the total nitrogen and phosphorous loading produced by the country as a whole (OSPAR, 2006). There have been previous efforts of compiling data on nitrogen and phosphorous loads from aquaculture, however based primarily on estimates rather than monitoring data (see EEA, 2003, for further references). European experts however indicated that these figures would have to be viewed with significant caution (CONSENSUS, 2005d). In any case, there is no clear evidence that this loading has resulted in significant undesirable changes in the wider coastal environment (EEA, 2003). The discharges, although only indicative, also contributed to the overall load from inland and coastal areas together with discharges from agriculture, forestry, industry and domestic waste (EEA, 2003).

CONTROL AND IMPROVEMENT OF ENVIRONMENTAL QUALITY

An evaluation of general EIA system performance in eight EU countries (Barker and Wood, 1999) found that due to an EIA being carried out, modifications to projects took place in most case studies undertaken as a result of the EIA process. The EIA process had having a notable effect on the number of project modifications taking place. Most modifications were undertaken by developers prior to submission of their applications for authorization. In some cases modifications took place at the decision-making stage, although opinions expressed during the earlier consultation and review stages were influential in the adoption of modifications during decision-making. On the basis of interviews, literature searches and general EIA data analysis it appeared that the consultees were more influential than the public in proposing modification measures. Consultation and public participation can influence modifications at both the pre-submission and the post-submission phases of the EIA process in most of the countries studied. The involvement of consultees and the public prior to submission of EIA reports was an important factor in proposing modifications to projects.

There is limited information available specifically on aquaculture EIAs. However, studies by Androulidakis and Karakassis (2006) and RPS Group PLC (2007) indicated that the Environmental Statements completed by contractors or private bodies outlined the main impacts on the environment well, but were poor at specifying monitoring requirements or fully analysing alternative sites or environmental mitigation through technology use. However, in many regions monitoring of environmental quality is statutorily part of the legislation and therefore often considered beyond the remit of the EIA within these regions. Specifying further monitoring may be confusing or simply ignored as "not legally required". One conclusion from these studies was that generally EIAs are not an effective way of gathering the required information to control and improve environmental quality and that maybe a more structured procedure would be more appropriate.

THE USE OF EIA GENERATED INFORMATION FOR IMPROVED MANAGEMENT

Information obtained through the EIA process is designed to provide information to allow decision-makers to judge whether a development can take place or not. Use of data and information generated through the EIA process is inconsistent depending on the location or region. In many eastern European regions implementation of EIA legislation is infrequent and little policing is done, meaning that the EIA often has no role in the decision-making process. In other countries where the role of EIA in aquaculture is more refined within the licensing framework, use of this information is often inconsistent as well. Often the information is given different weighting depending on whether is was specifically asked for by the statutory regulatory bodies within the scoping process, or potentially other political or public agendas. For example, in Scotland much weight is given to the visual impact assessment as part of an environmental assessment. This is not necessarily poor use of the information as other aspects, such as direct impacts on water and/or sediments may be addressed elsewhere in the licensing process which is taking place in parallel with the EIA and for which different reporting is often done (for example issuing of individual discharge consents). However, this is often an indication of wasted effort and thus lack of efficiency within the EIA process.

Many producers view the environmental assessment and environmental monitoring as part of the application and licensing process and only make use of this information if required to do so by regulations. For example, much information is derived for maintenance of environmental quality, but the measures put in place by regulators such as setting production or size levels to conform to Environmental Quality Standards (EQSs) is seen as achieving environmental sustainability. Some larger producers use the EIA as part of the process of implementation of Codes of Practice or accreditation schemes (i.e. ISO 14001, or organic status). The conclusions and recommendations contained in the EIA may form part of the "environmental policy" of the company. Public perception of aquaculture in Europe and North America has been generally negative in terms of environmental impacts and management. The production and publishing of EIAs and can contribute to alleviating fears of most of the public.

In the United States of America a number of states are using BMPs as voluntary or required components in their effluent regulations and for guidance and education for producers and regulators. Some BMPs have been developed for specific species and associated production systems. Additionally, numerous research studies are underway or planned at regional and state levels to identify technologies and practices that have measurable benefits for environmental protection and are affordable and practical for implementation at facilities. This research and development work is expected to continue and result in improved BMPs that support both environmental protection and producer adoption (Tucker *et al.,* 2003). For example, the "Best Management Practices for Channel Catfish Farming in Alabama" (Boyd, 2003) have been adopted by the USDA Natural Resources Conservation Service (NRCS) to supplement the Service's technical standards and guidelines. The guide sheets address a variety of topics, including reducing storm runoff into ponds, managing ponds to reduce effluent volume, controlling erosion, using settling basins and wetlands and implementing feed management practices (Tucker *et al.,* 2003).

REVISION AND REVIEW OF EIA AND MONITORING PROCEDURES

As the EU Directive on EIA is implemented at both an international and national level, there is some allowance for EU Member States to carry out regular revision and review of the prevailing EIA system and monitoring procedures for aquaculture. Various evaluations of performance of the EIA process have been undertaken (e.g., Barker and Wood, 1999*;* Wood *et al.*, 1996).

In 2003, the European Commission published its report "On the Application and Effectiveness of the EIA Directive (Directive 85/337/EEC as amended by Directive 97/11/EC): How successful are the Member States in implementing the EIA Directive?" (European Commission, 2003). The report examined key areas covered by the EIA Directive. These included *inter alia*: "screening" (determining whether an EIA is required for a specific project), "scoping" (identification of content of environmental impact study- EIS) and decision-making (authorising the project). The report also examined how Member States dealt with EIA issues such as alternative options, public participation and quality control. Nine shortcomings were identified in the following areas:

- The unsystematic "screening" of Annex II projects. Annex II of the Directive lists the categories of projects that have to undergo an EIA if they are likely to have a significant impact on the environment;
- Wide variation between Member States in the criteria for "screening". This means that a certain project would be subject to an EIA in one Member State but not in another;

- Poor "scoping". "Scoping" is the process of identifying the content of environmental impact studies;
- Insufficient consideration of the cumulative effects of projects;
- Processing of transboundary EIAs require more formal and informal consultation;
- Poor quality control systems for the EIA process. Setting quality control systems is not an obligation deriving from the Directive itself but it is left to the Member States;
- Variable levels of EIA activity between Member States, i.e. different numbers of EIAs carried out in the Member States;
- The inadequate incorporation of EIA results in development decisions;
- Incomplete transposition of Directive 97/11.

The general conclusion of this review report was that even after fifteen years of application the EIA Directive had not been properly implemented within all Member States, with most infringements of those EIAs reviewed (65%) being concerned with the bad application of the Directive in relation to individual project.

A review of the performance of the EIA system in Greece (Androulidakis and Karakassis 2006) showed that EIA studies frequently failed to address critical issues of the EIA despite the fact that all of them had followed the same legal framework on the structure of the EIS and subsequently the competent authorities have approved them. EIA studies for new developments carried out in Greece are often simplified, without the contractors or reviewers taking into account crucial elements and procedures, which should be included and thoroughly elaborated upon. The inadequate competence and multidisciplinary nature of the study groups and authorities themselves is considered one of the fundamental problems in the procedures of EIA. Some of these groups tended to lack appropriate scientific background to tackle all issues regarding the environment and the technical characteristics of each project. Problems also arise due to the large number of EIAs submitted and the small number of reviewers examining them. The time allocated to examine each study is significantly short and consequently it is uncertain that a detailed and thorough examination is carried out. The majority of EISs in Greece performed rather poorly in respect of most indicators used and there was little evidence of improvement with time. It is concluded that the authorities in charge still have little experience in coping with the increasing bulk of project submissions and are primarily interested in conformity with formal requirements rather than in reliable predictions and in overall quality of the EIA procedure.

Hence, Androulidakis and Karakassis (2006) point out that in Greece and possibly in several other EU countries, there is a need to address whether the review of the environmental assessments submitted are carried out by state or private bodies, which could lead to a vicious circle with no end-point. They conclude that the optimal reviewing measure could be applied by the well-informed public, who can act and judge the situation in an unbiased manner. This would be particularly useful for aquaculture, however in certain countries where aquaculture has received damaging media coverage, it would be very difficult to find an objective public.

There is limited documentation on the review of EIA procedures within North America. Much of the implementation of the outcomes of the EIA are implemented through best management practices at farm level. In Canada there are regional differences in the implementation of EIA and monitoring procedures with New Brunswick (east coast) having practices which are based on the same legislation but implemented in a different context to that in British Columbia (west coast). There have been reviews on the application of impact information, for example in British Columbia, where a review of aquaculture practice has just been published (British Columbia Legislative Assembly, 2007). This has the overall objective of defining aquaculture policy within a difficult political framework involving considerable environmental lobby pressure and traditional rights of indigenous populations. However, there is no documentation found on the review and assessment of the EIA procedures employed and how effective they are.

In the United States of America, where legislation is complex (see Section 2), there is little review and assessment of the process. There is considerable interest at the present in looking at aquaculture and its sustainability, as can be seen, for example, in the US Commission on Ocean Policy and the US Ocean Action Plan (USA, 2004). The former is concerned specifically with increase of targeted aquaculture research at NOAA and the latter includes the establishment of a regulatory structure for the further sustainable exploitation of offshore aquaculture. There is nothing specific however in either of these policies on the review, assessment or improvement of the existing or future EIA process for aquaculture. There is no documented information on the effectiveness of inland aquaculture EIAs in the United States of America. Again, best management practices through implementation of codes of conduct tend to be the method of acting on environmental policy. These management practices are under review by accrediting bodies through which they are implemented, e.g. the WWF through their series of dialogues on a number of commonly cultured organisms, including salmon and tilapia (see review by Boyd *et al*., 2005). However, there is no specific information on EIA or environmental monitoring of aquaculture.

STAKEHOLDER PERCEPTION OF EFFECTIVENESS OF EIA AND MONITORING IN AQUACULTURE

There is no available published or documented information available, despite extensive searching, that can be reviewed to study, analyse or research stakeholder perceptions in European and North American countries. Projects such as CONSENSUS (2008) and PROFET (2008) give information on the opinions of the stakeholders in terms of environmental indicators for sustainability and environmental policy but no detailed analysis which can be used here in terms of effectiveness of implementation of environmental impact assessment regulations.

It is important for all stakeholders to have a realistic understanding of the role that EIA is intended to play in development approvals. Also, in order to ensure continued support for the EIA process, its benefits need to be explicitly recognized and acknowledged and if necessary, action taken to add value.

An interesting study published by the IUCN (2004) commented on the methods of improving environmental sustainability of aquaculture in the Mediterranean Sea. Several conclusions were made for a variety of sustainability factors, one being the improvement of environmental impact assessment and monitoring. These factors were addressed from the side of the producers, national/international bodies and researcher's side. The improvements from the producers' point of view were based on the development of appropriate tools for "valorisation" of best practices, improved feed management and monitoring and improvement of techniques for monitoring of environmental impacts.

To some extent many of these issues have been addressed through a number of research and development projects,funded through the EU including CONSENSUS (2008), MERAMED (2007) and ECASA (2007). There is still some way to go on implementing these into actual farm practice through systems such as, for example, the sustainability protocols developed through CONSENSUS, and some of these are being incorporated into FEAP codes of practice.

In terms of mitigation or alternative management options which could be considered in EIA processes there is the potential for use of integrated aquaculture systems where more than one species, usually a combination of net contributors and net users of nutrient wastes, are grown close to each other. This should be incorporated into the EIA in terms of the consideration of alternative sites or technologies for the Mediterranean

Sea (IUCN, 2004) and in Canada (Cross, 2006). This could also include the application of artificial habitats for rehabilitation of aquaculture-degraded habitats. The IUCN study also highlights that different EIA legislation is applicable to different systems and sizes of aquaculture. There is a need to simplify the criteria and its implementation. In addition, it is suggested that there should be a system of public minimum guarantee (where the impact study is produced by the public sector authorities) and the private sector would only provide complementary information. This would integrate local public and private investment to everyone's benefit (IUCN, 2004).

There is little documented information on stakeholder perception of EIA effectiveness. Practical experience shows that many producers consider EIAs as a complicated, expensive and non-essential activity during the development stage of their farm. Little of the information is used directly by them in day-to-day farm management, though it is accepted that environmental regulators may use this information to impose management practices upon the farmer. Producers generally consider the regular statutory environmental monitoring, where measured parameters are compared with EQSs, more useful in terms of recognising sustainability of their farm's environment. Only large aquaculture companies which implement Environmental Accreditation Schemes (e.g. ISO 14001) would directly use the EIA information as part of the scheme's requirements.

Possible improvements

Although improvements in EIA efficiency and EIA report quality have occurred across Europe and measures are being taken to strengthen procedures relating to nearly every stage of the EIA process, it is still felt by all of the various stakeholders that there is room for improvement.

The shortcomings in the implementation of the EU EIA Directive which were identified in 2003 (European Commission, 2003) reflect earlier criticisms and deficiencies outlined by Wood *et al.* (1996). Various methods were suggested to increase the quality and effectiveness of EIA reports and therefore enhance the number and extent of environmentally beneficial modifications to projects. These suggestions include:

- strengthening the treatment of alternatives (to ensure early consideration of modifications);
- strengthening screening (to ensure that all significant projects are assessed);
- ensuring that scoping takes place by adopting formal scoping requirements (to encourage early recognition of the need for modifications);
- introduction of strategic environmental assessment (to ensure that environmental impacts are considered very early in the planning process);
- institute formal checks on the quality of EIA reports to ensure that mitigation is fully considered and that modifications ensue;
- strengthening provisions for consultation and public participation (to increase the number of proposed modifications);
- institute EIA monitoring and auditing to ensure that modifications are implemented;
- undertake research into various aspects of the EIA process, in order to replicate and expand on the results reported here and to refine these recommendations to meet particular national circumstances.

More recently a question as to the necessity for a full adoption of EIA process for marine fish farming has been (and is being) addressed in Scotland, based on salmon, but of relevance to all finfish culture including cod and halibut. Here it was discovered that even though the full EIA process and initial monitoring/baseline studies were undertaken, sites were nonetheless rejected using a set of basic rules. Rejection or acceptance of the development was still based on the points within the original scoping requirements, often ignoring other additional information provided. In addressing this inconsistency, a “toolkit” for the initial process of environmental impact assessment of marine fish farming was produced for the Scottish Aquaculture Research Forum (SARF) (RPS Group PLC, 2007). The aim of this “toolkit” was to give practical guidance to developers on potential issues that may arise that would either negate the reason for the EIA or reject the aquaculture system on environmental grounds at an early stage. A series of templates was developed for completion from which planners and regulators could make early recommendations on the appropriateness for continuation of the EIA process within a planning application. These templates can be considered a substitute for pre-application and full planning application for marine aquaculture and even for the environmental statement produced as a result of the EIA. Though these are mostly relevant to salmon aquaculture, they are also applicable to Atlantic cod and halibut and could potentially be used for all type of aquaculture applications. The existing templates are available (SARF, 2007) as blank forms, which may be completed *in lieu* of an EIA. The templates were developed after consultations, workshops and review of existing

EIAs. Though these were based on coastal salmon aquaculture, the scoring system used to grade the EIAs reviewed was based on methods of Lee *et al.* (1999), to assess overall quality and compliance with minimum statutory requirements (see Annex 4). This process is clearly an improvement and if implemented in this form elsewhere in the EU (albeit with templates specific to each individual country's legislation), it may smooth the process and decrease the present level of bureaucracy.

Improvements in the process of assessing environmental impacts in the wider sense may be gained through the introduction of Strategic Environmental Assessment (SEA). SEA is a process to ensure that significant environmental effects arising from policies, plans and programmes are identified, assessed, mitigated, communicated to decision-makers, monitored and that opportunities for public involvement are provided. The importance of this is becoming more widely recognised, but is targeted at more strategic development:

- to support sustainable development;
- to improve the evidence base for strategic decisions;
- to facilitate and respond to consultation with stakeholders;
- to streamline other processes such as Environmental Impact Assessments of individual development projects.

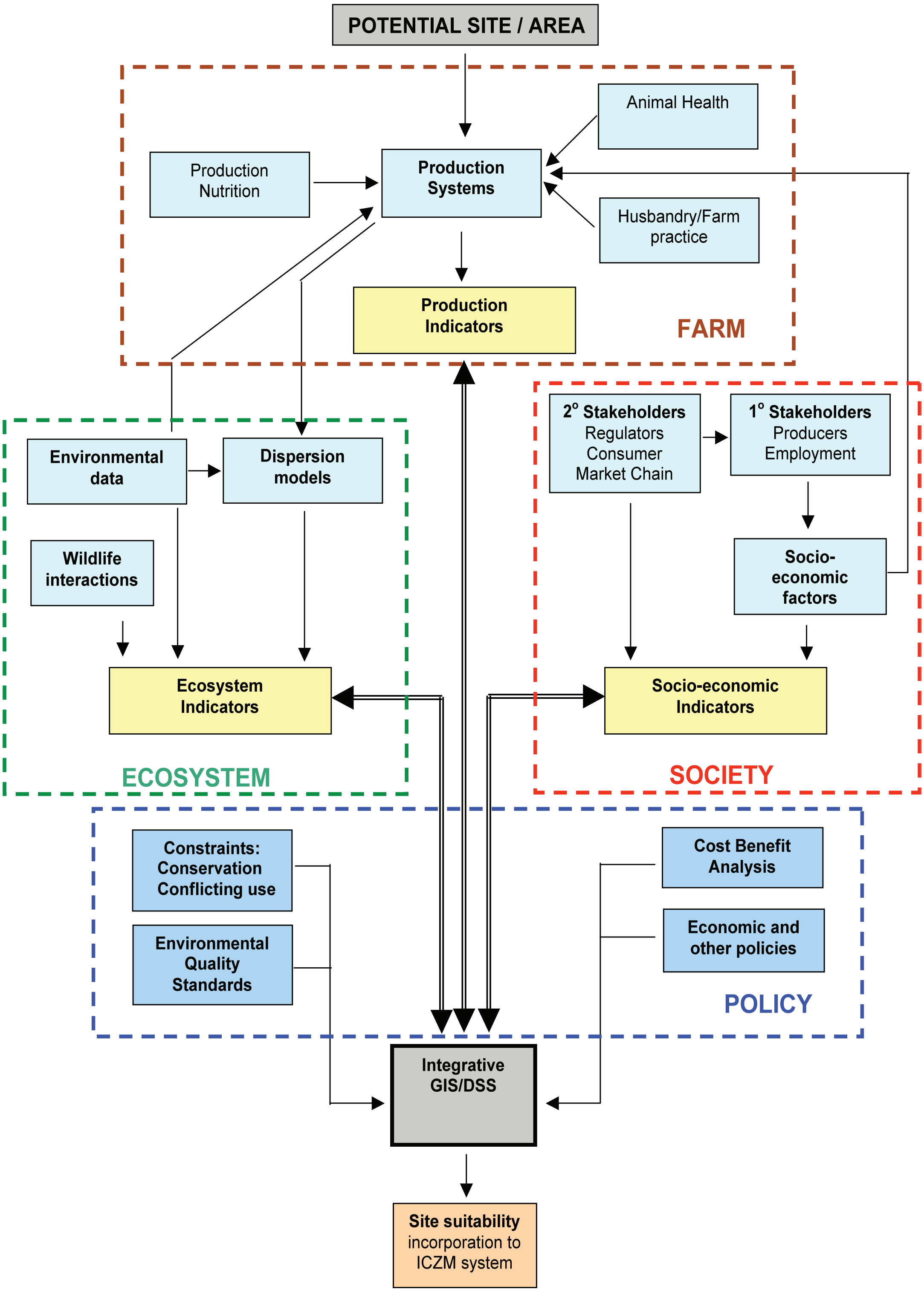
A particular form of SEA was being introduced by the European Union Directive 2001/42/EC (European Commission, 2001). This requires national, regional and local authorities in Member States to carry out strategic environmental assessment on certain plans and programmes that they promote.

SEA is clearly designed for a more strategic approach and therefore would be inappropriate for individual aquaculture developments. However, it would be of considerable use in considering aquaculture impacts in terms of area, regional or national strategy. For example, an SEA could be performed for an area containing a number and variety of aquaculture systems or developments. This would complement the approach under investigation by SARF, where individual development EIAs may be "performed" using the template approach (as described above) and this could feed into a more strategic plan for a larger area. This would be complemented by different wider-reaching modelling systems which can investigate multiple and combined impacts and incorporate the concept of carrying capacity for aquaculture. This can be used not only for incorporating impacts of new or previously developed aquaculture sites, but for more effective selection of sites for potential new developments and included within integrated coastal zone management plans and policy.

An approach for incorporating much of the information provided through the EIA and SEA processes through a single modelling and data collation process involves the use of geographic information systems (GIS). Models such as that presented in Hunter *et al.* (2006) and Hunter *et al.* (2007) could be widely used to integrate this process. These models are still under development but GIS as a tool for management of aquaculture is becoming more popular and widespread by development organizations including the FAO (e.g. Kapetsky and Aguilar-Manjarrez, 2007). The GIS approach to the selection of sites of offshore fish farms is recommended in the "Code of conduct for responsible aquaculture development in the US exclusive economic zone" (NOAA, 2003).

The main thrust of these models is to link complex databases of environmental (including requirements of EIA and environmental monitoring), socio-economic, farm level production information and governmental policy information in a single spatial framework to create an integrated GIS-based Decision Support System (DSS) for aquaculture development and regulation. Figure 6 shows a conceptual model of this approach. The ecosystem-based models for this approach have already been developed (Hunter *et al.*, 2006). This system would allow developers to isolate sites for the development of aquaculture on the basis of all of these criteria and again pre-model

FIGURE 6
Conceptual model of an integrative GIS-based decision support tool for effective implementation of aquaculture development



Source: Hunter et al., 2006.

GIS: Geographic information system
DSS: Decision support system
ICZM: Integrated coastal zone management

much of the criteria for development. In some cases, this may be a complex and time consuming process to implement fully, however even at its simplest level, GIS mapping and spatial analysis will enhance future implementation of the EIA and environmental regulatory process, through data storage, manipulation and acquisition.

Environmental monitoring procedures are often complex and inconsistent between countries. Most methods investigate water quality and/or sediment-based parameters and compare these measured parameters to environmental quality standards (EQSs) set by the environmental regulators and based on best scientific knowledge. Where possible the level of the EQS has been set at a threshold perceived where significant environmental impact occurs or where sustainability is impaired. In some countries, there has been a trend of combining the EQS method of assessment with modelling of waste distribution and combining different environmental parameters into a single index of effect (Gillibrand *et al.,* 2002). The purpose here is to simplify the requirements of environmental monitoring by concentrating on a few key, but easy to measure, parameters (e.g. sediment redox potential), which are indicative of environmental change as a whole. This is a good approach and should be investigated further. It has the advantage of simplicity, reduced requirements for sampling, reduced potential for error, ease of sampling, reduction of costs of sampling and greater potential for effective comparison between studies and monitoring programmes. This would give a more consistent and, to the environmental regulator, more meaningful implementation of monitoring procedure. However, a note of caution should be introduced. These indices or parameters are very good for comparison with EQSs and thus effective regulation, but they must be very carefully defined using extensive environmental data. They should be specific and defined differently for different environments (e.g.. between NE Atlantic and Mediterranean systems). In addition, they would give little information which can be used for comparative research to further existing knowledge of the impacts of aquaculture on the ecosystem sustainability as, by their nature, they simplify data collection and thus less information is available to make detailed overall conclusions. Therefore in this circumstance the distinction should clearly be made between collection of data for environmental regulation (comparison with EQSs) and for scientific research into the impacts of aquaculture on the ecosystem.

Conclusions and recommendations

Although there is now a greater understanding of the environmental impacts of aquaculture, improvements in existing EIA and monitoring requirements in Europe and North America still require more in-depth investigation. This will be an initial step to identifying the greatest risks posed by aquaculture installations and help pinpoint the most important parameters that should be monitored or investigated, therefore streamlining the EIA and environmental regulatory process.

Much research remains to be done regarding the dynamics of waste input, responses from the sediments in terms of the interactions between microbial and macrobiological processes, how these influence the chemistry of the sediments, and the physical processes of oxygen supply, sediment resuspension and mixing by water currents. In addition, inter-annual variability in biological factors, such as the supply of invertebrate larvae, probably has effects that are not as yet well understood.

Further studies of phytoplankton abundance and species composition are required to bring together long-term programmes of monitoring of nutrients, phytoplankton and algal toxins and understanding better the water movements within lakes, rivers, coastal bays and fjords and their interaction between the different waterbodies.

In terms of shellfish cultivation, especially in the EU, a fuller understanding of the interaction of suspended-culture mussel populations with other components of the ecosystem, in terms of their scope for growth (phytoplankton availability), their impact on other suspension feeders in the food web and the potential for nutrient release from accumulated biodeposits is required. Such studies should be linked to the development of models to assist in calculation of appropriate stocking densities for each bivalve cultivation area and the identification of sites where mussel cultivation could be practised to advantage.

A greater understanding of the potential benefits of integrating aquaculture species through more and larger scale research may also be an interesting prospect, using a combination of nutrient extracting species on-site with nutrient enriching species, with a view to increased productivity in the former and a net reduction in nutrient release from the latter. This may lead to a different system requirement for the EIA process and specific environmental regulation.

Finally more information is required on the long-term environmental fate of medicants and anti-foulants and their potential toxicity to pelagic and benthic organisms commonly found in the proximity of fish farms within the EU and North America. Antifoulant usage by the aquaculture industry should be better quantified. Copper and zinc concentrations, speciation and toxicity in fish farm sediments should be further investigated. It may be that a better understanding of finfish metal dietary requirements is needed to reduce metal concentrations in feed and consequent metal input into the marine environment.

The development and improvement of legal and institutional frameworks within the aquaculture industry will continue, but the issues of enforcement and monitoring of compliance with environmental regulations, especially requirements for EIA and regular environmental monitoring are still to be addressed in many countries. In addition, even where there is a mechanism for implementation of the EIA procedure, this is over complicated and often too bureaucratic in many countries. Implementation of standard legislation at regional, state or country levels in a consistent manner would facilitate better and more streamlined implementation of EIA and environmental regulation. The implementation of the more meaningful ecosystem approach to environmental analysis, which allows for all ecosystem impacts to be included in this process rather than individual developments, would be a more meaningful assessment of the actual sustainability of our aquatic environments in relation to aquaculture and its future development.

A more strategic approach to environmental assessment (SEA) may well be pursued through a combination between simplified and more targeted EIA procedures and legislative monitoring and an all encompassing SEA process including assessment of the wider carrying capacity issues and strategic socio-economics implications and the more focused use of wider sustainability indicators and codes of practice/conduct (see CONSENSUS, 2005). This could be built into national and possibly regional legislation. SEA enables many layers to be taken into consideration. This would conform well to a European legislation and to the mixtures on local, state and federal legislation in Canada and the United States of America.

It is of critical importance that future development of the industry and research are effectively linked in those areas where environmental management and performance can be improved, for example research on better site locations, better diets and less expensive protein sources; technological innovations on feed manufacturing and efficient use of energy. More research is needed for the implementation of integrated aquaculture at larger production scales followed by training and extension so that the farmers are able to implement these approaches effectively. Capacity building and knowledge transfer is important particularly to develop and implement better management practices. Also more effective communication is needed at all levels both to share experiences in better management of the sector to all concerned and create dialogue and partnerships to improve understanding and find solutions to the pressing environmental issues affecting the development of this important food producing sector (FAO, 2006).

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ANNEX 1

EU Environmental Impact Statement requirements for marine fish farms under Council Directive (85/337/EEC amended by Directive 97/11/EC; European Commission, 1997).

Under the European Union Council Directive 97/11/EC amending Directive 85/337/EEC, the overall format and content of an Environmental Impact Statement (EIS) is specified in the Second Schedule of the Regulations (see Article 25; appended further below). In addition, applicants are requested to ensure that the data requirements listed below are incorporated into the EIS.

Note: EIS should be presented as a single bound submission comprising narrative and appended technical studies.

1. The description of the physical characteristics of the project should include the location, number and type of cages, as well as details of moorings and any other floating structures proposed. Associated land based facilities (including facilities for disposal of dead fish) should be described. Transport requirements (land and sea) to and from the site should be detailed and related to existing infrastructural facilities such as roads and piers. Requirements, if any, for additional infrastructural facilities should be specified.
2. The description of the production processes should include quantity of fish to be harvested annually. Quantity and type of food to be used should also be specified.
3. The estimate of type and quantity of expected residues and emissions should include details of fish farm effluent characteristics. All chemical and antibiotics intended for use in stock treatments should also be listed.
4. The description of those aspects of the environment likely to be significantly affected by the project should include the following:
   - sediment study – including type, depth and redox potential;
   - a baseline survey of water characteristics:

– Physical	Temperature profiles
	Salinity profiles
	Water transparency
– Chemical	Oxygen tension
	pH
	Ammonia (total)
	Nitrate
	Total N
	Total P
	Silicate
– Biological	Phytoplankton
	Chlorophyll
	Zooplankton
	Benthic fauna

Note: Selection of control sites/monitoring stations is extremely important in order to follow natural fluctuations, seasonal cycles etc.

- details of shellfish beds and fisheries in the area;
- commercial activity in the area (sea and environs);
- recreational activities (including water sports, boating, angling and bathing);
- implications for wild fish stocks in the area.

5 The likely significant effects of the project on all other beneficial users of the sea and environs (including scenic aspects) should be detailed.

6 The description of the likely effects of the project on the environment resulting from the emission of pollutants and elimination of waste should give details of the potential effects of the fish farm effluents and chemicals on the waterbody as a whole; the sea bed; and other fish/shellfish life in the area. This section should therefore include the conclusions derived from a depth survey and a hydrodynamic investigation, both of which should be included as appendices.

The hydrodynamic investigation should specifically address the following:

- the movement and eventual degradation of solid waste from the farm;
- the effect of the fish farm effluent on the chemistry of the waterbody as a whole (this will involve an estimate of the turnover time of water in the bay);
- the time and concentration of chemicals used on the fish farms in the vicinity of shellfish beds.

Sufficient field measurements must be undertaken to enable these assessments to be made.

In open sites with no sensitive areas (e.g. shell fish beds) near-by, the first point above needs to be considered. This will involve, at the very least, current measurements of speed and direction at three depths over a complete tidal cycle.

In other areas additional field measurements will be necessary to enable the required hydrodynamic investigation to be carried out. The Department should be advised in advance of the proposed parameters to be measured.

7 The description of the measures envisaged to avoid, reduce or remedy adverse effects of the fish farm should include the following:

- consideration of the ability of the cages to withstand wave conditions likely to occur at the site. A wave climate analysis will be required to determine this and should be included as an annex;
- details of measures envisaged to prevent escapes;
- details of anti-predator measures;
- details of navigational lighting and marking or cages;
- details of proposed arrangements for bleeding of harvested fish.

Second Schedule – Article 25
Information to be contained in an Environmental Impact Statement

1 An environmental impact statement shall contain the information specified in paragraph 2 (referred to in this Schedule as "the specified information").

2 The specified information is –

(a) a description of the development proposed, comprising information about the site and the design and size or scale of the development;

(b) the data necessary to identify and assess the main effects which that development is likely to have on the environment;

(c) a description of the likely significant effects, direct and indirect, on the environment of the development, explained by reference to its possible impact on –

- human beings
- flora
- fauna

- soil
- water
- air
- climate
- the landscape
- the interaction between any of the foregoing
- material assets
- the cultural heritage

(d) Where significant adverse effects are identified with respect to any of the foregoing, a description of the measures envisaged in order to avoid, reduce or remedy those effects;

(e) a summary in non-technical language of the information specified above.

3 An environmental impact statement may include, by way of explanation or amplification of any specified information, further information on any of the following matters –

(a) the physical characteristics of the proposed development, and the land-use requirements during the construction and operational phases;

(b) the main characteristics of the production processes proposed, including the nature and quantity of the materials to be used;

(c) the estimated type and quantity of expected residues and emissions (including pollutants of surface water and ground water, air, soil and substrata, noise, vibration, light, heat and radiation) resulting from the proposed development when in operation;

(d) (in outline) the main alternative (if any) studied by the applicant, appellant or authority and an indication of the main reasons for choosing the development proposed, taking into account the environmental effects;

(e) the likely significant direct and indirect effects on the environment of the development proposed which may results from –

- the use of natural resources
- the emission of pollutants, the creation of nuisances and the elimination of waste;

(f) the forecasting methods used to assess any effects on the environment about which information is given under subparagraph (e);

(g) any difficulties, such as technical deficiencies or lack of knowledge, encountered in compiling any specified information.

In paragraph (e), "effects" includes secondary, cumulative, short, medium and long term, permanent, temporary, positive and negative effects.

4 Where further information is included in an environmental impact statement pursuant to paragraph 3, a non-technical summary of that information shall also be provided.

ANNEX 2

Environmental Impact Assessment requirements for shellfish farming in Canada (DFO, 2002a)

The information identified in this section is to be collected by the proponent and compiled in the form of a report to be provided to the DFO assessor responsible for the environmental assessment of the aquaculture project.

Project Description

Contact Information

Provide the following contact information for the project:
- name and address of proponent (including company name);
- name of principal contact person;
- telephone and fax numbers; and
- email address.

If the EA information submission was prepared by a consultant(s) or another group on behalf of the proponent, provide contact information for the agency or individual(s).

Indicate which other permits, licences and approvals for which you have applied.

Physical Location and Site Detail

Provide a copy of a topographic map, navigational/bathymetric/nautical chart or orthophoto map showing the exact location of the proposed tenure, aquaculture facility and the onshore facilities used to access the site.

Provide a detailed sketch or plan (to scale) of the site and specify:
- latitudinal and longitudinal corner and centre co-ordinates of the site;
- datum (NAD 27 or NAD 83); and
- dimensions of the site.

Provide the surface area of the proposed site and area of production (m^2 or hectares).If the application is for an expansion, provide the area of the existing site (m^2 or hectares) and the proposed expanded area (m^2 or hectares).

Briefly describe the location of the point of access for the proposed site (i.e., wharf, slipway) and locate it on the topographic map or nautical chart (from #1 above). Use nearby area features such as landmarks, islands, highways, wharves, etc. in this description.

On the map, draw a 2 km circle and 5 km circle around the proposed site with the site situated in the centre. Within the 5 km circle, indicate the location of all other users of the area (e.g. other aquaculture operations, shellfish beds, processing plants, campgrounds, cottage communities, municipal or industrial sources of effluent, tourism operators, navigational channels, First Nations territories/reserves, commercial, recreational and aboriginal fisheries, any known future projects and activities, etc.). This may be available from the province or another source. An equivalent mapping plan with the same information, if available, can be substituted for this either all or in part – all available information relative to other users is expected to be included in the proponent's submission.

Within the 5-kilometre circle on the map, identify the location of any environmentally sensitive areas surrounding the proposed site (e.g., rearing or spawning habitat, migration corridors, protected areas or proposed protected areas, location of streams and connected waterbodies such as lakes, wetlands, sensitive migratory bird habitat, areas used extensively by marine mammals, etc.).

Briefly describe the current use of the foreshore/shoreline of the land adjacent to the proposed site. Provide the name the shorefront property owner, if applicable. Indicate the water depth at all four corners of the site at lowest and highest tides. 8. Describe the site selection process, including the opportunities and constraints that were evaluated in the process.

Indicate whether the proposed site adheres to regional or provincial siting guidelines. If yes, indicate how and why. If not, indicate why not.

Design & Operational Plans

Construction and Installation
Provide labelled scale drawings of the proposed aquaculture facility in two dimensions (plan view and cross sectional view). Include all equipment such as mooring system, anchors, long lines, floats, tables, trays, socks, rafts, predator nets, etc. Include details of any land-based components, as applicable.

Note: If it is anticipated that the operation will be expanded in the foreseeable future, provide a second set of drawings illustrating the expanded layout. Provide a detailed description of any plans for future expansion including approximate dates of completion. Include the addition of works, diversification of species cultured, any future infrastructure, or any other plan that might affect the site. If it is anticipated that the infrastructure will be moved within the tenure boundaries, provide drawings of likely alternate siting configurations.

Is the site sub-tidal or intertidal?

Describe the anchoring / mooring system (e.g., screwed in, non-attached, etc.) and explain the placement and installation procedures to be employed.

Provide details on how the structures will be installed and the type of machinery or equipment required for installation, operation and harvesting.

For Bottom Culture
Provide a description of the type of structure(s) to be used and associated works such as predator nets/car cover (e.g., type of material, dimension and mesh size); fences and supporting structures (e.g., type of material, dimension and mesh size); tables (e.g., numbers and dimensions).

Indicate the area of the bottom covered by these structures.

Will beach modifications be required? If yes, provide details about what will be modified, how and when the modifications will occur.

Note: If beach modifications are proposed (e.g., addition or removal of substrate, creation of rock berms/windrows), it may be necessary to obtain an authorization under subsection 35(2) of the Fisheries Act from Fisheries and Oceans Canada (DFO.

In addition, there may be provincial requirements which must be met. Consult DFO and provincial authorities on these requirements.

For Near-Bottom Culture

Describe the culture technology to be used. Provide the appropriate dimensions of bags, socks, trays, cages or tables as well as the number of units. For example:

- tray type;
- height of table, frame or trestle from sea bottom;
- tray dimensions; and
- number of trays per stack.

Give the total number of tables and units to be used on a yearly basis, as well as the expected number at full site utilization.

For Suspension (Long-Line) Culture (Off Bottom)

Give the number and dimensions of longlines and/or rafts. If the site is being developed incrementally, provide details on the developmental phases, including schedule.

Provide information regarding the culture units to be used for growing. Include a description and the dimensions of gear. For example, include:

- type and number of culture units (i.e., socks, trays, lanterns, etc.);
- if lanterns, give the number of levels per unit and the diameter of each level;
- if trays or bag units, specify dimensions;
- if socks, specify the length to be used;
- number of lines on site, length of lines, space between lines;
- specify spacing between units on longlines;
- specify total number of units per longline; and
- number and dimension(s) of flupsy(ies) (floating upwelling systems), including anticipated flow at peak production.

Describe grow-out husbandry techniques and practices (i.e., raising and lowering of longlines, cleaning of in-water equipment, etc.) to be implemented.

Infrastructure

Describe other facilities, either existing or proposed, associated with the proposed aquaculture operation including during the construction and installation phases. These may include wharves, access roads, staff facilities, portable washrooms, oceanfront property, land facilities, etc. Indicate the location of these facilities on the topographic or orthophoto map or nautical chart provided. Include details and a schedule of what activities will take place and where.

Note: *A specific permit under provincial or federal legislation may be required for such works/activities. Contact the provincial agency(ies) responsible and DFO Habitat Management or Navigable Waters Protection Programme for additional information.*

List standard operating procedures and planned mitigation measures to mitigate any potential harmful effects of the installation, construction and operation phases of the facility. Measures may include ensuring that the construction site remains clean, siting the operation away from sensitive fish habitat, installing silt fences at specific locations to minimize deposition of silt into the marine environment, ensuring that shoreline areas are not harmed by construction activities, and environmental monitoring. Details regarding these measures will be required to provide assurance to DFO officials that potential environmental effects can be mitigated.

Note: *Mitigation measures (measures to mitigate) are actions taken to avoid, reduce or minimize effects on the environment. These may include such actions as timing activities to avoid migration times of aquatic species or conducting in water activities during low tide or isolating in-water activities to reduce habitat disruption.*

Describe facility inspection and maintenance procedures, including their frequency and the actions to be taken. Discuss daily, weekly, monthly and yearly maintenance requirements, as well as post-event (storms, predator incursions, etc.) inspection and maintenance procedures.

Production

Specify the species and source of shellfish to be raised, including the spat collection technique and location.

Confirm your plan to obtain a licence through the Introductions and Transfers Committee(s) for the transfer of your stock from one location to another.

Note: The transfer of fish (including shellfish) from one location to another requires a review by DFO (and perhaps the provincial) Introduction and Transfers Committee, and a licence pursuant to section 56 of the Fisheries (General) Regulations.

Seed and brood stock imported inter-provincially or internationally must be certified disease free. Further details will be required for the Introduction and Transfers Committee.

Provide the total stocking biomass and estimated production (harvest) level at the site.

Describe seeding, maintenance and harvesting procedures including scheduling and transportation of product from the production site to the processing plant. Describe any measures to be implemented to mitigate potentially harmful effects resulting from harvesting and transportation activities.

Indicate location and methods of disposal of shell, rope, socking, net debris, etc. The *Canadian Environmental Protection Act* (CEPA) prohibits the deliberate disposal of any substance at sea unless the substance is specified on Schedule 5 of CEPA. Deliberate disposal at sea of specified substances requires a Disposal At Sea permit from Environment Canada under section 127 of CEPA (Environment Canada, 2001). Before being granted such a permit, the proponent will have to show that all other disposal or recycling and reuse options have been evaluated and an extensive review by Environment Canada will be required.

Ancillary Management

Predator Control

Describe measures to be taken to minimize predator (birds, mammals, other fish, crabs, etc.) attraction and interaction (e.g. minimal perching areas; barrier systems; visual and/ or acoustic deterrent devices, etc.). Provide details on how these measures may affect the predator.

Note: *Destruction of "fish" by means other than fishing may require an authorization under section 32 of the Fisheries Act from DFO.*

Note: *Environment Canada's Canadian Wildlife Service (CWS) has a "Policy for the Issuance of Scare Permits for the Aquaculture Industry". To minimize impacts on migratory birds while protecting aquaculture operations against depredation of their crop, this policy places strong emphasis on siting considerations and early avoidance of problems. Contact CWS for information on this policy or go to: http//www.cws-scf.ec.gc.ca/1_pdf/Aqua.pdf.*

Note: *Proponents should also contact DFO and provincial wildlife agencies with regard to their predator control policies and regulatory requirements.*

Anti-fouling

Provide details for any anti-fouling materials that may be used and describe how each may be applied, including location, method and frequency of application. Also describe any mechanical removal processes used. Explain where the fouling organisms and other water/material will be disposed. 2. Provide details of the rope and gear cleaning procedures and location(s) where cleaning will take place.

Hazardous & Human Waste Materials

Provide a list of any hazardous materials that may be used on site (e.g., cleaning agents, fuels, etc.). Provide details regarding the transportation, use, storage and disposal of these materials and their containers (e.g., paint cans, oil containers).

Describe the procedure used for collection and disposal of routine garbage and human wastes generated on site.

Decommissioning

Should decommissioning be required, describe the process, including measures to restore the area to its pre-development state.

Accidents & Malfunctions

Identify potential risks from malfunctions or accidents that may occur during the installation, operation and decommissioning phases of the project (e.g., fuel spills, storm destruction, extraordinary loss of shellfish, etc.). Discuss operational plans (such as boat and equipment safety protocols, staff presence on the site) to prevent such accidents and malfunctions and contingency plans (including emergency spill response plans, containment and cleaning of spills) to deal with each of these potential situations, including details of appropriate equipment and materials to be kept on site. What is the expected response time to deal with an onsite emergency?

Existing Environment

Note: *It is recommended that proponents meet with DFO officials early in the project planning process. Such a meeting will serve to help identify site-specific information requirements, environmental factors to be considered and the anticipated level of effort and detail that may be required in collecting and compiling information for the EA. It is an opportunity to direct the information gathering process and to focus the efforts of both the proponents and the reviewers.*

Aquatic Environment

Oceanographic

1. Provide the following information pertaining to the proposed site:
    - range of depths (metres) throughout the site (a profile diagram is useful to convey this information).

- these can be obtained from a hydrographic chart of the area. Indicate the chart number.
- if you provide soundings that you have taken yourself, also provide the date the soundings were taken and the start and finish times. State if the soundings you provided have been reduced for tide.

- what is the higher high water large tide (HHWLT) in metres and the lower low water large tide (LLWLT) in metres?
  - these can be obtained from tide tables or hydrographic charts for the area.
- what is the minimum depth (in metres) between the bottom of the aquaculture facility or structures and seafloor at LLWLT?
- what is the direction of maximum fetch at the site?
- estimate the maximum wave height (in metres).

Note: Some government agencies provide oceanographic data on their Web sites. For example, Oceans Science Web site for Maritimes Region (www.mar.dfompo.gc.ca/science/ocean/home.html) and Pacific Region (www.pac.dfompo. gc.ca/sci/osap/) includes such information as ocean currents, water temperatures, salinity. As well, information is available on the St. Lawrence Observatory site (www.osl.g.ca). It may be beneficial to check such sites.

Water Quality

Some measures to characterise the food supply are useful for calculating the potential carrying capacity of the site. These include suspended particulate matter (SPM), particulate organic matter (POM) or chlorophyll. This information is most necessary in areas of shallow depth and/or restricted water exchange where effects of particle removal by filter feeding cultured species is expected to be greatest. DFO will confirm, based upon site characteristics, the extent to which this information is required, on a site-by-site basis.

Provide the Secchi disk depth (the depth at which a 30-cm diameter black and white disc disappears from site under calm conditions during the day) can be used to calculate SPM if direct measurements are not available.

List any other known organic matter inputs and/or sources of contaminants that may exist within the bay or which may be in close proximity to the site. These may include sources of contaminants resulting from raw sewage, agriculture activities, log boom storage, forestry, effluent from fish processing plants, disposal at sea, land-based industries, etc. Indicate how these activities or inputs/contaminants could affect the site and aquaculture operation.

The Canadian Shellfish Sanitation Program (CSSP), jointly administered by DFO, Environment Canada and the Canadian Food Inspection Agency (CFIA), provides for the continuing evaluation of the level of contamination in the water overlying shellfish growing areas and their classification as to sanitary quality. Specify whether the proposed site is located within a shellfish classification area. If so, specify the current classification and the date of the most recent survey. If not, specify the location of and distance to the nearest classified area and the date of its most recent survey.

Note: As a starting point, check the Shellfish Growing Area Classification Index at www.ns.ec.gc.ca/epb/sfish/maps/class.html for the East Coast and www.pyr.ec.gc.ca/ep/shellfish/shell_e.htm for the West Coast. Contact DFO or Environment Canada for more information. Note that this information is not available in Quebec.

Note: Sampling guidelines/protocols for Currents and Benthos may be obtained from DFO – Habitat Management.

Currents

In general terms, describe the current - is it relatively weak, medium or strong? Current description should be based upon the following:

Weak	< 2 cm/s
Medium	2–10 cm/s
Strong	> 10 cm/s

Benthos

Note for the following section in particular, various factors may affect the level of information and monitoring required as outlined in the Preface. Consult with DFO to confirm whether this information is required for your project.

Characterize the benthic habitat. Where depth and turbidity permit, an underwater video record *should* usually be obtained using a diver-operated (handheld) camera. In deeper water, a towed camera system can be used. [Guidelines for obtaining video recordings of bottom conditions can be obtained from Habitat Management.] The visual survey provides critical information on both marine life in the area (e.g., invertebrates, fish and plants), as well as seafloor characteristics (substrate size, relative proportions) at the proposed lease site. Where other types of surveys have been conducted (bottom raking survey, bottom type surveys) include the information they have produced.

In intertidal areas, characterization of the benthic habitat *may* require a standardized, transect-based habitat survey including a description of the assessment area (habitat observations, maps and photos). DFO officials will indicate for which projects this will be required.

Information *may* be required on the percent organic matter (weight loss on ignition at 550 C for four hours) in surface sediment and sediment type through samples collected using benthic grabs and/or cores. This provides an indication of sediment characteristics prior to organic enrichment and, therefore, indicates the potential for assimilation of organic by-products.

Depending upon depth and currents at the site that create the potential for organic enrichment or depending upon the distance to sensitive fish habitat, there *may* be a requirement for additional measurements of specific water column (SPM, POM and chlorophyll a) and sediment (Eh, total sulphides and organic content) variables. General information on water depth, variability in current speed over a tidal cycle and sediment texture should be sufficient to indicate if additional environmental data is required.

Biological Environment

Note: *For this section, a number of resources should be consulted to collect information. These may include an underwater video survey, commercial and recreational fishers, aboriginal groups, Fishery Officers, local fishery organizations, other local residents, etc. A great deal of information concerning fishery resources is available to the public through local regional development authorities. Ensure that all information transfer is documented and attached. It is the responsibility of the proponent to demonstrate* *a reasonable effort to collect information. Provide details about the sources of the information (contact name, agency, phone number, etc.).*

From the video survey (when conducted) and collected site knowledge, describe fish habitat at the site. A map indicating substrate type (silt, sand, gravel, cobble boulder) plants (eelgrass, kelp) significant patches of animals (urchins, lobsters, crabs, sea cucumbers, etc.) and any other habitat features (e.g., rocky outcrop) should be provided. Include approximate abundance of each component, i.e., percent cover or number of individuals observed in a given area.

Standard Sediment Grain Size Fractions:

Boulder > 256 mm	Sand 2 – 0.062 mm
Cobble 64 – 256 mm	Silt 0.062 – 0.004 mm
Gravel 2 – 64 mm	Clay <0.004 mm

List other fish species that may use this area as spawning, rearing, or over-wintering habitat. Include the source (name, agency, publication, etc.).

Note: *Under section 34 of the Fisheries Act, fish habitat is defined as "spawning grounds and nursery, rearing, food supply and migration areas on which fish depend directly or indirectly in order to carry out their life processes".*

Note: *Under section 2 of the Fisheries Act, the definition of fish includes "…shellfish, crustaceans, marine animals and… the eggs, sperm, spawn, larvae, spat and juvenile stages of fish, shellfish, crustaceans and marine animals".*

Does this site lie within the migratory route of any fish species? If so, identify the species and the predicted time(s) of migration.

What is the distance from the site to the nearest stream(s)? If the site is less than one kilometre away from the stream, provide information on physical habitat of the stream, including photographs, steepness at the mouth of the stream and presence/location of any fish species, life stage, etc., which may inhabit the stream either seasonally or year-round.

Identify the type(s) of potential predators (e.g., birds, seastars, crabs, snails, mammals, etc.) that may interfere with the operation. Give the time of year they are most prevalent, noting particularly the presence of breeding areas, colonies, spring and fall staging areas, wintering areas, food sources and feeding areas.

Are any species at risk associated with the site? If so, provide details as to the species that may be present permanently or temporarily, as well as food sources, feeding areas and any proposed recovery plans.

Note: *Contact the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) at www.cosewic.gc.ca or Conservation Data Centres (CDC) at* www.abi-canada.ca*.*

Are there any areas in close proximity to the proposed site where birds are likely to congregate, such as ecological reserves, National Wildlife Areas, government parks, Migratory Bird Sanctuaries, Ramsar Sites, Important Bird Areas, or Western Hemisphere Shorebird Reserve Network Sites? If yes, provide details, including species likely to be present, breeding areas, colonies, staging areas, wintering areas, food sources and feeding areas.

***Note:** Information is available at www.cws-scf.ec.gc.ca/cwshom_e.html or contact the regional offices of the Canadian Wildlife Service (Environment Canada). In addition, also consult Environment Canada's Environmental Assessment of Shellfish Aquaculture Projects: Guidelines for Consideration of Environment Canada Expertise at* www.atl.ec.gc.ca/assessment/facts.html*.*

Socio-Economic Environment

Note: Under CEAA, the Responsible Authority (RA) is required to consider any effect of any change that a project may cause in the environment, including any effect of any such change on socio-economic conditions.

Describe any fishing activities (e.g., commercial, Aboriginal or recreational fisheries), tourism operations, recreational activities (e.g., boating, diving, skiing, swimming, etc.) in the vicinity of the site that could potentially be affected by changes in the environment resulting from the establishment and operation of the proposed aquaculture site. Provide information on their time(s) of operation and proximity to the site.

Provide contact names and comments received from any other users, such as fishers or their association(s), tourism operators, etc., that have been contacted to discuss the proposed development.

***Note:** Under CEAA, the RA is required to consider any effect of any change that a project may cause in the environment on the current use of lands and resources for traditional purposes by aboriginal persons.*

Could the project have an effect on aboriginal people and use of their lands for traditional purposes? Indicate why or why not. If there are aboriginal persons that could be affected by your project, summarize any discussions and correspondence you have had with them.

Note: For information on Aboriginal groups, contact either the First Nations Tribal Councils or Band Council identified at www.johnco.com/firstnat OR the appropriate regional office of Indian and Northern Affairs Canada at www.inac.gc.ca*.*

Does the proposed site contain anything of historical, archaeological, paleontological, or architectural significance? If so, explain its significance.

Note: Parks Canada, Canadian Heritage and/or a local natural history museum, or other cultural agencies in the area may be able to assist.

Is the proposed site near potential or existing Marine Protected Areas (MPAs) or other federally or provincially classified parks? If yes, specify which one(s) and their locations.

Note: Contact DFO, Parks Canada and provincial authorities for information.

Public Consultation

Provide information on and copies of, any advertisements and public notices regarding the proposed development, including the date(s) and sources (e.g. newspapers, radio; newsletters, etc.).

Describe the public notification and consultation process. Provide names of contacts and dates of meetings or interactions. Provide information on comments and recommendations received in support of or in opposition to the proposed venture. Indicate how the issues raised by these parties may be addressed.

Changes to the Project Caused by the Environment

Note: *Environmental effect also includes: any change to the project that may be caused by the environment.*

Identify any changes to the project that may be caused by the environment. Aspects of the environment, such as weather and climate, tides, toxic and non-toxic algal blooms, wind and wave effects and ice, should be considered. Identify measures to be put into place to mitigate these changes. If available, provide a copy of any studies or supporting material, such as engineering reports.

Cumulative Environmental Effects

Note: *Under CEAA, DFO is required to consider any cumulative environmental effects that are likely to result from the project in combination with other projects or activities that have been or will be carried out.*

The concept of cumulative effects is the recognition of the complex ways in which the environmental effects of individual projects and activities interact and combine with each other over time and distance. Thus, to address cumulative environmental effects in environmental assessments requires *thinking cumulatively*. This means giving consideration to: (1) the temporal and geographic boundaries of the assessment; and (2) the interactions among the environmental effects of the project, other existing and future aquaculture and non-aquaculture projects and activities. The mapping exercise specified above, Question 5, as well as the other information provided by the proponent,, will serve to identify potential environmental effects that exist within the 5 km circle around and beyond the proposed development site. The actual area for potential cumulative environmental effects around a proposed site may vary depending upon the physical characteristics of the location. Based on information provided and other available information, DFO will assess the scope, likelihood and significance of adverse cumulative environmental effects associated with the proposed shellfish aquaculture project. The proponent may be requested to provide additional input to assist with the assessment of cumulative environmental effects. As with environmental assessment in general, there is no one approach or methodology for all assessments of cumulative environmental effects. Different circumstances, such as location of project and type of potential environmental effects will dictate appropriate methodologies. Where information may be lacking, qualitative approaches and best professional judgement are used.

Follow-up Programme

As part of this exercise, the RA may conclude that a follow-up programme (monitoring) is required to verify the accuracy of the environmental assessment and to determine the effectiveness of mitigation measures implemented. The proponent will be required to comply with the monitoring programme, including carrying out any sampling required and ensuring that monitoring results are provided to DFO.

ANNEX 3

An example of an environmental risk matrix for shellfish farming in Canada (DFO, 2002a).
(Available: http://govdocs.aquake.org/cgi/ content/abstract/2004/410/4100270)

A. Marine Habitat (including water quality)				
Project Activity	**Potential Environmental Effects**	**Possible Mitigation**	**Significance of Adverse Environmental Effects**	**Follow-up Monitoring**
Construction and Operation	Reduced water quality and effects to water column flora and/or fauna. Organic loading, smothering or alteration of habitat. Impacts on the health of local marine organisms. Reduction of phytoplankton in the ecosystem.	Avoid low water exchange areas for large projects (intense culture). Minimize in-water activities to reduce release of sediments and sediment-laden water into any waterbody. Time in-water activities to avoid migration and spawning windows. No foreshore modifications without consulting the DFO. Locate sites where current and flow provide adequate movement of nutrients. Catch nets or double socking to catch fall-off.	Determination of significance of adverse environmental effects to be made by DFO.	Established monitoring programme.
Refuse Disposal	Waste accumulation in the water column and on benthic habitat. Degradation of water quality.	Solid waste to be removed from site and disposed of in an appropriate manner (no disposal of materials to the water column). Periodic removal of all garbage (e.g. ropes, socks) from site and disposal in approved landfill. Catch nets or double socking to catch fall-off.	Determination of significance of adverse environmental effects to be made by DFO.	
Accidental events/spills (e.g. fuel, hydraulic fluid and lubricants)	Degradation of water quality. Release of hazardous materials. Effects to shellfish health and production.	Use of less toxic alternatives to hazardous products. Development of Emergency-Spill Response Plan. Designation of areas for storage and refuelling with proper containment. Training of workers in the effective use of fuel and lubricants.		
Debris accumulation on the sea bed	Alteration of the substrate by smothering.	Catch nets or double socking to catch fall-off. Waste products to be removed from site and disposed of at a suitable location.		
Biofouling control measures (physical removal and treatment of equipment	Degradation of water quality (increased particulates, toxicity to some species).	Use of appropriate defouling methods and proper disposal of waste. As appropriate, allow fouling organisms to be released back into suitable habitat, rather than allow to 'dry-out'. Land or boat-based defouling.		
Placement and removal of anchoring system	Physical disturbance to benthic habitat.	Minimize extent of in-water activities. Provide minimum buffer zone around sensitive habitats like eelgrass, saltmarsh and kelp beds.		

B. Fisheries Resources

Project Activity	Potential Environmental Effects	Possible Mitigation	Significance of Adverse Environmental Effects	Follow-up Monitoring
Construction and Operation	Alteration of fish migration patterns.	Locate sites away from important migration routes. Meet all siting guidelines.	Determination of significance of adverse environmental effects to be made by DFO.	

C. Wildlife (including birds, crabs, mammals and species at risk etc)

Project Activity	Potential Environmental Effects	Possible Mitigation	Significance of Adverse Environmental Effects	Follow-up Monitoring
Construction and Presence of Infrastructure (e.g. physical presence, noise, disturbance, attraction) and bird deterrent programmes	Predator attraction to sites as a food source. Alteration to staging and distribution patterns. Disturbance to shorebirds and displacement or reduced access to traditional areas of use. Entanglement/drowning of birds in predator nets.	Site selection to reduce predator interest and areas with large numbers of migratory birds. Proper on-site maintenance and cleanliness. Predator management plans. Mesh sizes of predator nets should be in accordance with recommendations of the Canadian Wildlife Service, Environment Canada.	Determination of significance of adverse environmental effects to be made by DFO.	
Accidental spills (e.g. fuel and lubricants)	Potential mortality from oiling. Long-term effects e.g. impairment to reproduction.	Use of less toxic alternatives to hazardous products. Proper storage of materials. Develop Emergency-Spill Response Plan. Spill kits to be maintained on-site in case of accidents. Designation of areas for storage and refuelling with proper containment. Train workers in the safe and effective use of fuel and lubricants. All machinery to be in good working condition, free of leaks.		Further monitoring after Emergency-Spill Response.

D. Traditional Use of Lands and Resources by Aboriginal Persons

Project Activity	Potential Environmental Effects	Possible Mitigation	Significance of Adverse Environmental Effects	Follow-up Monitoring
Access to site and harvesting activities.	Interference with use of infrastructure (wharf, roads etc).	Consult with local aboriginal groups. Avoid areas of lands and resources currently used for traditional purposes. Meet all siting guidelines.	Determination of significance of adverse environmental effects to be made by DFO.	
Construction and Operation	Interference with traditional uses.	Consult with local aboriginal groups. Avoid areas of lands and resources currently used for traditional purposes. Meet all siting guidelines.		

E. Fisheries Activities (e.g. commercial, recreational and aboriginal)				
Project Activity	**Potential Environmental Effects**	**Possible Mitigation**	**Significance of Adverse Environmental Effects**	**Follow-up Monitoring**
Operation of aquaculture site/ vessel traffic	Interruption of access to fishing areas.	Abide by Navigable Waters Protection Act (NWPA) approvals and conditions, including site-marking requirements. Consult with local fishermen and other marine user groups. Avoid sites with significant fisheries. Maintain access to site by fishermen, as operational and safety conditions permit. Meet all siting guidelines.	Determination of significance of adverse environmental effects to be made by DFO.	

F. Historical, Archaeological, Paleontological and Architectural				
Project Activity	**Potential Environmental Effects**	**Possible Mitigation**	**Significance of Adverse Environmental Effects**	**Follow-up Monitoring**
Site operations and activities.	Information gap identified.	Consult with interested and knowledgeable parties. Avoid areas of significant physical and cultural heritage. Background check into history of area.	Determination of significance of adverse environmental effects to be made by DFO.	

ANNEX 4
Quality assessment method as applied to aquaculture EIAs in Scotland (RSP Planning, 2007 – Scottish Aquaculture Research Forum Report 024)

The reviewer is instructed to read all of the advice for reviewers and read the review topics (areas, categories, subcategories) for familiarity. A key part of the evaluation should be whether the EIS was found to be:

- focused on the key questions;

scientifically and technically sound; and

clear and coherently organised so that it can be understood.

The reviewer is made aware of areas of weakness, omission or concealment in the EIS. These may occur when:

- certain tasks are omitted, unsuitable or *ad hoc* approaches are taken;
- bias or inaccurate supporting data (references) is provided; and
- the rationale or justification for conclusions is not given.

The review is then completed in line with the Lee & Colley methodology (Lee *et al.*, 1999). This method considers the quality of the EISs in four separate review areas as follows:

- description of the project and the environment;
- the identification and evaluation of key impacts;
- the treatment of alternatives and mitigation; and
- the communication of the information.

These are further broken down into categories and subcategories. In total, each ES was assessed against 55 criteria (for definitions of these see RSP Planning Ltd, 2007[1]). The grades for each criterion are combined to give a grade for each category and subsequently each review area and final overall grade for the EIS. The grades for each criterion are described below:

Grading system for Assessing the Quality of EISs

A	Relevant Tasks well performed no important tasks left incomplete
B	Generally satisfactory and complete, only minor omissions and inadequacies
C	Can be considered just satisfactory despite omissions and inadequacies
D	Parts are well attempted but must, as a whole be considered just unsatisfactory because of omissions and/or inadequacies
E	Not satisfactory, significant omissions or inadequacies
F	Very unsatisfactory, important task(s) poorly done or not attempted
NA	Not applicable. The Review Topic is not applicable or is irrelevant in the context of this Statement

[1] RSP Planning Ltd (2007) Literature, legislation and planning review environmental impact assessment marine fish farms prepared for Scottish Aquaculture Research Forum, Highland Council, and the Scottish Executive. Available at: www.sarf.org.uk/SARF024.htm.

Review of environmental impact assessment and monitoring of aquaculture in Latin America

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Saborio Coze, A. and Flores Nava, A. 2009. Review of environmental impact assessment and monitoring of aquaculture in Latin America. In FAO. Environmental impact assessment and monitoring of aquaculture. *FAO Fisheries and Aquaculture Technical Paper.* No. 527. Rome, FAO. pp. 395–454.

ABSTRACT

This review includes the results of a compilation and synthesis of the existing environmental impact assessment (EIA) and environmental monitoring (EM) practices for aquaculture-related activities, in six Latin American countries; namely Brazil, Colombia, Cuba, Ecuador, Honduras and Mexico. It is divided into three major segments: first, the legal framework that includes EIA and its procedures. Second the actual practice of environmental norms enforcement and follow-up, and finally, a series of recommendations to improve the effectiveness of such instruments.

The methodology included open-answer questionnaires sent to a representative number of actors in the aquaculture sector from each of the six countries. Subsequently, the main legal instruments dealing with aquaculture in every country were analysed, namely the General Constitution; the general environmental laws; the regulatory framework for environmental impact assessments and, when applicable, the specific legal framework for fisheries and aquaculture. Such analysis was based chiefly on the information made public by the country's authorities through Internet, and in two cases, Mexico and Brazil, using primary sources (government representatives). Finally, the document presents a series of recommendations to overcome the weaknesses detected in the analysis, especially those related to the actual compliance with the law and monitoring programmes.

CONTENTS

Acronyms and abbreviations

General	
BMP	best management practice
CITES	Convention on International Trade in Endangered Species
EIA	environmental impact assessment
EM	environmental monitoring
ES	environmental strategy
GIS	Geographic Information Systems
GMO	genetically modified organisms
HACCP	Hazard Analysis Critical Control Points
IDB	International Development Bank
NGOs	Non-Governmental Organizations
SEAP	The Special Secretariat for Aquaculture and Fisheries
UNDP	United Nations Development Programme
Brazil	
ABCC	The Brazilian Shrimp Growers Association (*Associação Brasileira de Criadores de Camarão)*
EEZ	exclusive economic zone
EIA/RIMA	Environmental Impact Study and Report of Environmental Impact (*Estudo de Impacto Ambiental e Relatório de Impacto Ambiental)*
IBAMA	Brazilian Institute of the Environment and Renewable Natural Resources (*Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis)*
MMA	Ministry of Environment *(Ministério do Meio Ambiente)*
PLDC	Local Plan for Shrimp Farm Development (*Planos Locais de Desenvolvimento da Carcinicultura)*
PLDM	Marine Aquaculture Development Plans (*Planos Locais de Desenvolvimento da Maricultura)*
RAS	Simplified Environmental Report *(Relatório Ambiental Simplificado)*
RGP	General Fishery Register (*Registro Geral da Pesca)*
Colombia	
CARs	Autonomous Regional Corporations
ICA	Colombian Institute for Agriculture and Livestock
INCODER	The Colombian Institute for Rural Development
POT	territorial management plans
Cuba	
MIP	Cuban Ministry of Fishing Industry
MEP	Cuban Ministry of Economy and Planning
MAC	Cuban Agriculture Ministry
AAAr	Environmental Responsible Application Authority
TROs	Territorial Representation Offices of the Ministry of Science, Technology and Environment.

Ecuador

AAA	Environmental Application Authority
AAAc	The Environmental Cooperative Application Authority
AAN	National Environmental Authority
AAAr	The Environmentally Responsible Reinforcement Authority
MINA	The Ministry of the Environment
SUMA	System for Environmental Management

Honduras

DECA	The Environmental Evaluation and Control Directorate
SINEIA	National Environmental Impact Assessment Evaluation System

Mexico

CAN	National Aquaculture Chart
CONAFOR	National Forest Commission
CONAGUA	National Water Authority
CONAPESCA	National Fisheries and Aquaculture Commission
LGEEPA	General Law for the Ecological Balance and Environmental Protection
MIA	Environmental Impact Description
NOMs	Official Norms
POAs	aquaculture territorial management plans
PROFEPA	Environmental Protection Agency
PTF	Project Technical File
SAGARPA	Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food
SEDEMAR	Secretariat of the Navy
SEMARNAT	Secretariat for Natural Resources and the Environment
SENASICA	National Service of Animal Health, Food Safety and Agri-foods Quality
SRO	State Representation Offices
UMAs	aquaculture management units

Summary

Latin America has experienced an unprecedented growth of aquaculture as a result of a number of factors which include the recognition by local governments of the importance of this industry in their national economic diversification, and the comparatively higher level of competitiveness of the Latin American region, in terms of the availability and price of land, water, energy, skilled labour and price of inputs which, altogether, stimulated large international investment in the activity over the past 30 years.

The pace at which aquaculture has evolved throughout the region, mostly through intensive and semi-intensive systems, has been much faster than the capacity of local governments to plan and monitor the development of the sector, especially in relation to the environmental impact associated with unsustainable production practices, thus resulting in numerous examples of severe, some even irreversible environmental impacts in the region, particularly during the first rapid expansion of aquaculture in the 1970s, due to the lack of planning, specific zoning for aquaculture development and, in general, the lack of environmental management tools to ensure a sustainable development.

Over the past two decades, however, most aquaculture-producing countries of the region have introduced a series of regulatory measures for aquaculture practices at different levels. These range from simple, flexible, non-mandatory rules, through to strictly-enforced, compulsory legal acts that all aqua-farmers are obliged to follow. In addition, as more producers are incorporated into a country's export chain, along with tougher internal environmental protection norms, international agreements and requirements force such farmers to comply also with best management practices, thus gradually generating a whole culture of awareness of environmental issues related to aquaculture.

Through a series of open-answer questionnaires sent to academics, producers and government officials, as well as through the direct collection of secondary information published by government authorities, a review was made of the legal frameworks and technical methods for assessing the environmental impact and monitoring of aquaculture projects, in six Latin American countries, namely Brazil, Colombia, Cuba, Ecuador, Honduras and Mexico.

General environmental legislation is found in all countries reviewed, dating in some cases form the early seventies. However, specific aquaculture legislation has only been enacted in Brazil, Ecuador and Mexico in the past five years. Currently, most aquaculture-producing countries of the region are in the process of developing a specific aquaculture legal framework.

Environmental impact assessment tools have been officially introduced in all countries covered by this study. Generally speaking, it is a special technical and administrative procedure whose objective is to identify potential impacts and to prevent environmental deterioration generated by human activities.

Currently, numerous policies, instruments and environmental plans in most Latin American countries offer many alternatives to cope with environmental issues. Despite the diversity of such instruments, the general objectives are common to all countries:

i) to identify potential environmental impacts by specific human activities such that these can be avoided or mitigated;
ii) to increase public awareness on the environmental effects of non-sustainable production practices;

iii) to try to induce a positive change of economic actors regarding environmental protection;
iv) to improve the formulation of environmental policies;
v) to monitor the health of ecosystems as a key element for decision-making in environmental management.

Standard environmental impact procedures common to all countries reviewed include a preliminary EIA which, depending on the level of risk perceived by the analyst, can be assessed in more detail to decide whether the project is permitted or refused. The actual resolution on the EIA issued by the environmental authorities usually includes a series of conditions aimed at mitigating the potential environmental impacts that were identified. These may include a wide range of considerations. Some examples include infrastructure modifications, strengthening biosafety measures, wastewater monitoring, ecological studies of recipient waterbodies, potential predators control, etc.

As far as the actual effectiveness of EIA and environmental monitoring tools are concerned, stakeholders in the region believe that important steps have been taken as far as adapting national legal frameworks and introducing EIA tools for regulatory purposes in Latin America; however, a common denominator seems to be the lack of resources to carry out environmental monitoring of aquaculture projects and associated watersheds where they are present. Another drawback is that projects promoted by the government are treated with more flexibility than those promoted by the private sector.

In countries where there are official environmental norms specific for aquaculture projects (i.e. Brazil, Mexico and Honduras), these are fairly general and sometimes meaningless within a particular geographic context, regardless of its aquaculture importance. For example, the upper limits stated in Honduran norms for wastewater discharges, are much higher than those generally recommended as safe to avoid eutrophication of natural waterbodies elsewhere.

Furthermore, there is no official mechanism for regular revision of these norms derived from systematic environmental monitoring of ecosystems affected by aquaculture practices. This makes such norms obsolete in many instances or out of context.

Some recommendations for improvements identified in the present review, are the following:

- There should be a pre-determined timeframe for the systematic revision of the environmental regulatory framework for aquaculture in every country, taking into consideration a) changes in the international legislation, b) growth rate of the activity within each country, c) changes in the ecological conditions of specific aquaculture regions, d) technological and scientific developments contributing to more sustainable methods of production, e) global and regional tendencies regarding BMP and environmental certification.
- Revision of the regulatory frameworks should be participatory, thus including all stakeholders within the sector.
- It would be wise to consider the creation of more specific (state or provincial) regulatory frameworks to respond to local environmental contexts and issues.
- All countries should create specific aquaculture norms as environmentally precautionary reference points, especially related to: water quality associated to wastewater, management of exotic species, use of prophylactics and of therapeutic drugs; quality of supplementary feeds and overall biosafety measures, among other aspects. Again it is important to take into consideration the national and regional contexts, to avoid generalizations.

Introduction

Aquaculture can be developed in a sustainable manner to generate food, employment and improve the standard of living of the rural population, particularly in developing countries. However, in many instances, especially in developing countries, aquaculture is growing at a faster rate than the ecosystems´ capacity to replenish the resources used by this and other economic activities.

There is a universal consensus on the need to formulate scientifically-based, robust regulatory frameworks for the sustainable development of aquaculture. This has resulted in a growing number of countries formulating specific laws aimed at protecting the environment to ensure that resource-demanding activities such as aquaculture are practiced in a rational and sustainable manner. Moreover, farmers themselves have started to acknowledge the need to introduce sustainable management practices, thus creating codes of conduct and environmental certification programmes to stimulate more environmentally sound production management strategies.

Although the political will of governments and farmers' associations is fundamental, it is not the key factor determining the success of environmental policies, but rather the actual compliance with the law by all actors involved in aquaculture. Hence clear, integral legal frameworks, formulated in a participatory manner, as well as rigorous law enforcement systems, are essential if aquaculture is to be sustainable.

The present document reviews both legal frameworks for aquaculture and aquaculture-related activities, as well as the practical EIA procedures and the environmental monitoring activities derived from such assessments, in six aquaculture-producing countries of Latin America, namely Brazil, Colombia, Cuba, Ecuador, Honduras and Mexico. Finally a chapter of recommendations for improvement, stemming from the analysis, is presented.

BACKGROUND AND SCOPE

According to Morales and Morales (2005) and FAO (2006a, b), Latin America, with an average annual increment of 21.3 percent between 1950 and 2004, experienced the world's highest aquaculture growth rate over this period. Of the 31 countries that practice aquaculture in the region, Chile contributes more than 51 percent, followed by Brazil, Mexico and Ecuador, which together contribute more than 80 percent of the total regional aquaculture volume. Overall production in the region has grown by a cumulative 73 percent since 1994, reaching 1.34 million tonnes by 2004, thus representing 2.3 percent of global aquaculture production.

Even though the number of native species cultured either experimentally or commercially in the region is over 40, the bulk of the industry is concentrated on only a handful of introduced species of high commercial value aimed at export markets, namely the Atlantic salmon (*Salmo salar*) and other introduced salmonids in Chile; the white Pacific shrimp (*Litopenaeus vannamei*), cultured throughout the coastal tropical countries of the region including the Atlantic coasts where it is exotic, and tilapia (*Oreochromis niloticus*) of various strains, cultured intensively and semi-intensively in an increasing number of countries and regions of tropical and sub-tropical Latin America.

Other introduced species cultured commercially in relatively large volumes include carps (chiefly the common carp *Cyprinus carpio* and Chinese carps, i.e. bighead *Aristichthys nobilis* and grass carp *Ctenopharyngodon idella*), molluscs such as the Japanese oyster *Crassostrea gigas* and abalone (*Haliotis* sp), as well as a number of "emerging" marine and freshwater finfish species that are being introduced and intensively cultured for export purposes, such as cobia (*Rachycentrum canadum*) in marine environments and sturgeon (*Acipenser baerii*) in freshwater environments.

Only few native species are being cultured commercially in the region, although both the species diversity and their production volume are increasing. Such species include the pacu (*Piaractus mesopotamicus*) and the tambaqui (*Colossoma macropomum*), chiefly cultured in Brazil, and the striped mojar (*Cichlasoma urophthalmus*) in Mexico.

The unprecedented growth of the aquaculture industry in Latin America is the result of a) a gradual recognition by local governments of the importance of aquaculture in their national economic diversification, which led them to make important changes in their legal frameworks to foster investment in aquaculture and b) the comparatively higher level of competitiveness of the Latin American region with regard to more developed areas of the globe, in terms of availability and price of land, water, energy, skilled labour and price of inputs which, altogether, stimulated large international investment in the activity over the past 30 years.

However, the pace at which aquaculture has evolved throughout Latin America, (mostly through intensive and semi-intensive systems, which have a high demand for water, space, feed inputs and energy) has been much faster than the capacity of local governments to plan and monitor the development of the sector, especially in relation to the environmental impact associated with unsustainable production practices.

There are numerous examples of severe, some even irreversible environmental impacts in the region, particularly during the first rapid expansion of aquaculture in the 1970s, due to the lack of planning, lack of specific zoning for aquaculture development and, in general, the lack of environmental management tools that ensured sustainable development.

Over the past two decades, however, most aquaculture-producing countries of the region, have introduced a series of regulatory measures for aquaculture practices at different levels. These range from simple, flexible, non-mandatory rules, through to strictly-enforced, compulsory legal acts that all aqua-farmers are obliged to follow. In addition, as more producers are incorporated into a country's export chain, along with tougher internal environmental protection norms, international agreements and requirements force such farmers to comply also with best management practices (BMPs), thus gradually generating a whole culture of awareness of environmental issues related to aquaculture.

There are, nonetheless, big asymmetries among countries in relation to the actual enforcement and effectiveness of these regulatory measures. The scope of the present document is to compile the legal framework and structure employed by six representative countries of the Latin American region, in terms of their assessment of the environmental impacts associated with aquaculture practices, as well as to formulate recommendations for improvement.

METHODOLOGICAL APPROACH

The current review was done following the terms of reference presented in Part 4 – (this review) – Annex 1 and consisted of the collection of information published on each of the countries and abroad, in periodic journals, government Web sites and others (including FAO Web page), reports and publications. Additionally, the authors consulted through e-mail and telephonic communications with professionals on each country (see Annex 1). Finally, a questionnaire (Annex 2) was distributed to diverse individuals and organizations by e-mail (about 100 e-mails), however the reply was very low, less than 10 percent (see Annexes 3 and 4). Information provided by all these individuals contributed specially to the chapter on checking the effectiveness. The information on Brazil was provided in writing by Mr Felipe Suplicy. The authors are very grateful to all those contributors.

GENERAL INFORMATION

Background of the environmental legislation of Latin America

Over the past 20 years, Latin American environmental legislation has experienced rapid development, particularly after the United Nations Conference on Human Development and the Environment in 1972, which resulted in the Stockholm Declaration. Later, the Biodiversity Convention and the Climate Change Convention during the Earth Summit of Río de Janeiro in 1992 fostered a growing awareness of the need for legal frameworks aimed at environmental protection.

Other international agreements, such as the Rio de Janeiro Declaration on Environment and Development and Agenda 21, were also formulated at that Convention. These two conferences significantly influenced the proliferation of environmental norms in Latin American countries.

Some of the early environmental protection legislation in Latin American aquaculture producing countries includes the following:

- *Brazil:* (1981) Law No. 638: National Environmental Policy (Politica Nacional do Meio Ambiente) with its application instruments.
- *Chile* (1994) General Environmental Law (Ley General del Medio Ambiente).
- *Colombia:* (1974) National Code for Renewable Natural Resources and Environmental Protection (Código Nacional de Recursos Naturales Renovables y de Protección del Ambiente).
- *Cuba:* (1981) Law No. 33: Environmental Protection and Use of Natural Resources (Protección del Medio ambiente y el Uso de los Recursos Naturales) (derogated in 1997).
- *Ecuador:* (1976) Law for the Prevention and Control of Environmental Pollution (Ley para la Prevención y Control de la Contaminación Ambiental).
- *Honduras:* (1993) General Environmental Law (Ley General del Ambiente).
- *Mexico:* (1988) General Law for the Ecological Balance and Environmental Protection (Ley General del Equilibrio Ecológico y Protección Ambiental). This law substituted the Federal Law for the Protection of the Environment (Ley Federal de Protección del Medio Ambiente) in 1982.

As a general rule, the primary legal steps taken by Latin American countries as part of their environmental legal framework were directly related to the formulation of instruments to regulate the use of natural resources (i.e. permits, concessions, authorizations, licenses, etc). As environmental awareness and technical capacity of Latin American governments increased, the formulation of activity and/or resource-specific norms and standards aimed at preventing and/or mitigating environmental degradation, developed. Currently, most aquaculture-producing countries of the region have or are in the process of having a specific aquaculture legal framework.

The analysis of the legal instruments that relate to aquaculture of the countries included in this review reveals that the actual term aquaculture is, nonetheless, not included in any constitutional text, but rather approached from the viewpoint of the natural resources which aquaculture depends upon (i.e. water, land, aquatic biota, ecosystems, etc).

Introduction of EIA tools in aquaculture projects

Over the last three decades, there have been important changes in the legislation regarding aquaculture in Latin America. These include the development of scientifically-based policy instruments for environmental management and rational use of natural resources. Examples of this are the implementation of EIA methodologies, land use zoning for territorial management, sanctions related to responsibility for environmental harm, environmental economic valuation instruments, environmental protection activities and community participation in environmental issues.

Environmental impact assessment tools have been officially introduced in all countries covered by this study. Generally speaking, EIA is a special technical and administrative procedure whose objective is to identify potential impacts and to prevent environmental deterioration generated by human activities.

Currently, numerous policies, instruments and environmental plans in most Latin American countries offer many alternatives to cope with environmental issues. Despite the diversity of such instruments, the general objectives are common to all countries:

i) to identify potential environmental impacts by specific human activities such that these can be avoided or mitigated;
ii) to increase public awareness of the environmental effects of non-sustainable production practices;
iii) to try to induce a positive change of economic actors regarding environmental protection;
iv) to improve the formulation of environmental policies;
v) to monitor the health of ecosystems as a key element for decision-making in environmental management.

Through the years, there have been important national and international efforts to improve the technical qualification of the governmental agencies responsible for EIA. Moreover, re-design of EIA tools, which originated in developed countries with completely different environmental contexts, have been adapted to local or regional situations, thus increasing their usefulness and precision. Some recent examples of such efforts include attempts to locate the EIA in the context of the geographical organization or environmental classification of the territory; the obligation of any project promoter to carry out an EIA prior to any modification of a given site; the use of a participatory approach along the different phases of environmental impact assessment processes, and the mandatory nature of EIA as well as *ex-post* monitoring follow-up programmes as key instruments for the construction of early warning systems in ecosystem management.

Checking the requirements

BRAZIL

Environmental legal framework

Several specific decrees define the authorizations for aquaculture activities and aquaculture plans:

- (2003) Decree No. 4.895: defines the conditions for the authorization of aquaculture in federal waterbodies.
- (2004) Normative Instruction No. 6: defines complementary rules for authorization of aquaculture in federal waterbodies.
- (2005) Normative Instruction No. 17: defines the criteria and procedures for the formulation and approvement of Marine Farm Development Plans (PLDM).
- (2008) Normative Instruction No. 18: defines complementary Geographic Information System (GIS) criteria for the formulation of Marine Farm Development Plans (PLDM).

On the other hand the legal framework on the subject of Environmental Impact Study and Report of Environmental Impact (*Estudo de Impacto Ambiental e Relatório de Impacto Ambiental - EIA/RIMA)* contained in the Brazilian Constitution of 5 October 1998 states specific requirements for the installation of projects or activities that can potentially cause significant deterioration to the environment. In addition, Article 6 IV establishes that the executive organization that must oversee the compliance of policies is the Brazilian Institute of the Environment and Renewable Natural Resources (*Instituto Brasileiro de Meio Ambiente e dos Recursos Naturais Renováveis – IBAMA*), an administrative unit of the Ministry of Environment (Ministério do Meio Ambiente – MMA). The manual of environmental licensing elaborated in 2002 by MMA, IBAMA, United Nations Development Programme – UNDP and International Development Bank - IDB states that EIA/RIMA are necessary for the licensing of activities that cause modifications and significant impacts on the environment.

Proponents of aquaculture projects must submit their application to the Directory of Environmental License and Quality within IBAMA, who will classify the potential environmental impact of the enterprise according to their activity, jurisdiction, project phase and stage of environmental studies. Based on this classification, proponents may have to elaborate an EIA/RIMA, a Simplified Environmental Report (Relatório Ambiental Simplificado - RAS) or just fulfill the requirements to obtain an environmental license as listed in specific aquaculture regulations. In fact, an environmental license is required for the establishment of any activity that is likely to cause harm to the environment. As stated by CONAMA Resolutions No.1 of 1986 and No.237 of 1997, the set up of aquaculture farms requires environmental licensing. In fact, aquaculture is unarguably an activity potentially affecting the biota (flora and fauna of a region), the environment and the quality of natural resources (i.e. water resources), as required by the former resolution. Additionally, to avoid all doubts, the latter explicitly mentions the management of living aquatic resources (*manejo de recursos aquaticos vivos*) and the breeding of animals (*criação de animais*).

Legislation provides for three different types of environmental licenses, according to the stage of development of the project:

- preliminary licence (*Licença Previa,* LP): approving the concept-project and location;

- installation license (*Licença de Instalação,* LI): authorizing the setting up of the activity;
- operation license (*Licença de Operação,* LO): authorizing the commencement of the project.

The license procedure goes through the following steps:

1. determination (by competent authority and applicant) of necessary documentation to support the application (there are 22 classes of activities according to the type of required procedure);
2. filing and delivering of application to the competent authority, with supporting documentation (including EIA/RIMA, when required);
3. analysis of application and supporting documents;
4. request for clarification or additional documentation, if necessary;
5. public review, when required;
6. request for clarification or additional documentation, if necessary;
7. issue of conclusive technical advice and of legal advice, where appropriate;
8. granting or denial of license and publication.

Aquaculture investors whose projects are not set to be implemented in federal waterbodies, but in state rivers and dams and in private properties using ponds or cages, must refer to state regulations to obtain an aquaculture environmental license. According to the national environmental regulation, each state can propose its own criteria for environmental licensing, provided it is not more permissive than the federal regulation. As a consequence, strong differences in terms of procedures and criteria can be found in aquaculture environmental regulation among states. While in some states aquaculture is grouped together with other potential harmful activities like salt mining, in others there is no specific regulation. From 27 states, specific environmental regulation for aquaculture is in place in only 17. In some of them it covers finfish and shrimp farming, in a minority bivalve molluscs are included, but none have specific procedures for seaweed or amphibians.

Regarding shrimp farming, Resolution CONAMA No.312 of 2002 defines three categories of aquaculture facilities according to the size of the inundated area:

- small establishments (≤10 ha) shall undergo the simplified licensing procedure;
- medium establishments (>10 ha and ≤50 ha) are subject to the regular licensing procedure;
- large establishments (>50 ha) small and medium establishments causing significant harm to the environment and those located in the area of influence of other establishments must present an EIA/RIMA.

The resolution requires specific documentation to support applications and states the minimum content of the Environmental Control Plan (Installation License phase, LI) and the Environmental Monitoring Plan (Operation License phase, LO). The federal government is now developing a PLDM analogous process plan and manages shrimp farm areas, with the use of GIS and an integrated coastal management approach to identify and demarcate suitable areas for shrimp production. The draft version of this regulation, called Local Plan for Shrimp Farm Development (*Planos Locais de Desenvolvimento da Carcinicultura – PLDC)* is currently under public consultation.

Irrespective of the nature of the waterbody (public or private), all aquaculture farmers must also be registered within the General Fishery Register (*Registro Geral da Pesca – RGP*). Procedures for registration are defined in Normative Instruction N°3 /2004. Applicants shall file their applications through the SEAP Office of their State of residence, including the following supporting documentation:

- application form properly filled in and signed by the applicant or by a legal representative;
- for companies, a copy of a document attesting its legal status as a company;
- copy of the certificate of residence of the applicant;

- detailed projection of the existing or upcoming infrastructure;
- copy of the environmental license, when required;
- receipt of tax payment for aquaculture farmer registration.

Related "soft laws"

Shrimp aquaculture is the most extensively organized aquaculture sector in Brazil. The Brazilian Shrimp Growers Association (*Associação Brasileira de Criadores de Camarão,* ABCC) has developed four codes for best management practices concerning shrimp farming, shrimp feed production, shrimp hatchery operation and shrimp processing plants. These latter are mainly based on HACCP standards, whereas the former tackle the following issues:

Sustainable and responsible shrimp aquaculture management (*Código de Conduta para Desenvolvimento Sustentável e Responsável da Carcinicultura Brasileira*) (June 2004):

- mangrove conservation;
- site selection, standards and construction techniques;
- feed and feeding practices;
- shrimp health and biosafety measures;
- prevention of shrimp escapes;
- use of chemicals and veterinary drugs;
- hatchery management;
- harvest, conservation and transport;
- effluents and solid wastes;
- rights of other water users;
- relationship with employees and the local community.

Shrimp feed production (*Código de Conduta e de Boas Práticas de Fabricação para Fabricantes de Rações para Camarão*) (January 2004):

- site selection and location of facilities;
- selection and purchase of ingredients;
- storage and use of ingredients;
- processing;
- formulation;
- packaging and labeling;
- storage and transport of feed;
- human resources;
- sampling and testing methods.

Marine shrimp larviculture (*Código de Conduta e de Boas Práticas de Manejo para Laboratórios de Larvicultura de Camarão Marinho*) (May 2004):

- site selection and location of facilities;
- disinfection of the hatchery;
- operation and management;
- feed;
- animal health and biosafety;
- use of chemicals and veterinary drugs;
- harvest, packaging and transport;
- effluents and solid wastes;
- employees and social relations.

The Special Secretariat for Aquaculture and Fisheries (SEAP, its acronym in Portuguese) has prepared a draft version of a Best Management Practices Manual for fish, molluscs and frog culture, which are available for public consultation through the SEAP Web site, as well as the sustainable aquaculture management code from the ABCC:

- code of conduct for sustainable development of frog farming *(Código de Conduta para o Desenvolvimento Sustentável e Responsável da Ranicultura Brasileira*, June 2004);

- code of conduct for sustainable development of mollusc farming *(Código de Conduta para o Desenvolvimento Sustentável e Responsável da Malacocultura Brasileira*, June 2004);
- code of conduct for sustainable development of fish farming *(Código de Conduta para o Desenvolvimento Sustentável e Responsável da Piscicultura Brasileira*, June 2004).

These documents contain guidelines for the following activities:

- aquaculture site selection;
- farm construction/installation;
- feed and feeding practices;
- biosafety;
- control of cultured animals escapes into the environment;
- use and storage of chemicals and therapeutic substances;
- farm management practices;
- effluents treatment and residues disposal;
- consideration of other users rights of aquatic resources;
- consideration of rights and needs of local communities;
- relationship with employees.

Citizen participation

With regard to citizen participation, according to the law, when the EIA-RIMA is requested as part of the environmental license process, the study and related report will be accessible to the public if the applicant does not request its information to be confidential. The environmental impact assessment copies are at the disposition of any interested person or company in the centers of documentation and in the environmental agencies libraries. Public organizations that show interest in the study or have a direct relationship with the project will receive a copy of the EIA-RIMA if requested. At the end of the EIA and with the presentation of the RIMA, the competent authority (IBAMA or the pertinent state or municipality) will determine the date to receive comments from public organizations and other interested parties and it will promote a public hearing to deliver the information about the project and its environmental impacts.

COLOMBIA

Environmental legal framework

In Colombia, Decree 1220, in articles 7, 8 and 9, establishes that all projects need to obtain an environmental license to operate. The law also states that the EIA is the basic instrument for decision-making regarding projects and activities likely to affect the natural or an artificial environment.

The government entities that have the authority to grant or deny an environmental license are the Ministry of the Environment, Housing and Territorial Development, The Autonomous Regional Corporations for Sustainable Development and the municipalities, districts and metropolitan areas which have an urban population of over one million inhabitants (Article 2 of Decree 1220).

Some of the functions and responsibilities of the Ministry of the Environment are to establish the environmental norms and general regulations for urban centres and human establishments, as well as the mining, industrial and transportation sectors and, in general, every other service and activity that may generate environmental impacts.

Other functions of the Ministry of the Environment include ensuring the compliance of the regulatory framework to control and reduce pollution; to define and regulate the administrative instruments and mechanisms for the prevention of environmental deterioration, and determine the evaluation and environmental management criteria of economic activities in the framework of various legal instruments.

Wastewater discharges are regulated by Law No. 9 of 1979 and Legislative Decrees No. 2.811 of 1974 and No. 1.594 of 1984, which include water uses and liquid wastes. This latter decree sets the standards for water quality for the purpose of conservation of flora and fauna, including aquaculture.

As far as the import of exotic species into the country is concerned, the existing regulatory framework, establishes that the Ministry of Environment and The Colombian Institute for Rural Development (INCODER) must jointly grant the corresponding authorization. Under the terms of the Law No. 99 of 1993, the introduction of exotic species of flora or fauna that might negatively affect natural ecosystems and wildlife is subject to the granting of an environmental license by the Ministry of the Environment.

In addition, the Colombian Institute for Agriculture and Livestock (ICA), is the authority responsible for veterinary health certification for imports and exports in general, this includes fish, molluscs and crustaceans and their eggs, larvae or juveniles.

Regarding the use of water all projects are requested to apply for a water use permit. This together with an environmental management plan, are required by the Autonomous Regional Corporations (CARs) directly or through the compliance of environmental guides. In the case of shrimp culture, such guides already exist and guides for fish culture are currently being elaborated with the support of regional councils of the productive chain. The objective is to achieve an environmentally friendly and sustainable activity.

Environmental impact studies have to be presented together with the official environmental license application form. The authority then issues a resolution either granting or refusing the license.

Territorial Management Plans (POTs, their acronym in Spanish) have been formulated in some of the country's departments and municipalities. In many such POTs aquaculture has been labelled as an important economic activity for regional development, especially in those areas with waterbodies and soils adequate for fish farming.

Sanctions

According to the Colombian environmental laws, the environmental license can be suspended or revoked by the same environmental authority that granted it, whenever the license grantee has failed to comply with any of the terms, conditions, obligations or inherent responsibilities he is subject to by law.

Additionally, when an infraction is detected, daily fees are applied up to a sum equivalent to 300 minimum wages. Licenses, concessions, permits or authorizations may also be suspended. Temporary or definitive closure of projects and seizure of individuals or specimens of flora and fauna or of products or implements used to commit infractions are also sanctions included in the law.

When applicable, specific studies and evaluations can be carried out to establish the nature and characteristics of environmental impacts caused by the project. Subsequently, the necessary measures to mitigate or compensate for the damages are applied. (Law Number 99, 1993. Fundaments of the Environmental Policy of Colombia).

Article 18 of the same law states that if a project generates polluting wastes then a number of sanctions may be applicable, depending on the severity of the impact on the environment. They can include fines or the suspension or closure of projects. *Law 23 of the 12th of December of 1973. Code of Natural Resources and Protection of the Environment).*

Soft Laws

There is a mechanism that rewards products originated from renewable natural resources whose extraction, processing, etc, have been made employing environmentally sound practices that entitle the products to be certified with a "green label". Such eco-labels effectively translate into increased sales prices and consequently greater revenues for those that choose to comply with the strict standards required by the certifier.

Citizen participation

As stated in Article 76 of Law 99, before an environmental license is granted in regions where black and indigenous populations exist, there must be a public hearing. Moreover, the political constitution establishes that the law will guarantee the participation of the communities in all the decisions that may affect them. Any company or individual may intervene in the administrative process of issuing, modifying or cancelling permits or licenses to projects and activities that affect or may affect the environment.

A public hearing may be requested to be held before the authority decides on any EIA-evaluated project. This hearing is generally chaired by regional or federal environmental authorities.

Article 30 refers to community participation on the environmental evaluation and licensing processes. This article establishes that those communities located in the area of direct influence of the project, must be thoroughly and properly informed about its nature, likely environmental impacts and the proposed mitigating measures. Once the activities have started, the community must be periodically informed about the results of the implementation of the environmental management plan and the corrective measures that derive from it.

CUBA

Environmental legal framework

In Cuba, Article 24 of Law Number 81, the Law of the Environment, states that any human activity that poses an environmental risk, will require the granting of an environmental license by the Ministry of Science, Technology and the Environment.

An environmental impact assessment is demanded in cases of new projects, works, activities, expansions or modifications of projects that use natural resources or any source of energy. (*Resolution No. 77 / 99 Regulatory Framework of the Process of Environmental Impact Assessment of the Ministry of Science, Technology and Environment*).

Article 2 of the same regulatory instrument establishes that the government institution responsible for the supervision of the Environmental Assessment System is the Ministry of Science, Technology and Environment and its representative offices in the Cuban provinces.

The Environmental Law (1997) and the Regulatory Framework of the Environmental Impact Assessment Process (1999), are the most important elements of the Cuban EIA system leading to the granting of an environmental license. Aquaculture is explicitly mentioned among the activities that are subject to the EIA process.

The National Centre for Biosafety is the official agency responsible for processing all applications concerning projects or activities that involve biological agents and organisms, therefore aquaculture projects must also pass through the technical scrutiny of this entity.

The Ministry of Science, Technology and the Environment may analyse fisheries development plans and policies also employing EIA tools.

Cuban legislation deals with waste and wastewater produced by aquaculture through a series of general principles relating to appropriate wastewater treatment, reduction of water pollution and wastewater in general. The legislation on inland waters establishes four precautionary rules aimed at protecting freshwater resources:

- Extensive culture and capture of fish must comply with the provisions made by the National Institute of Water Resources and the Ministry of Public Health.

- Intensive and semi-intensive breeding of fish is not allowed in reservoirs used for human consumption.
- The establishment of intensive and semi-intensive fish breeding facilities is subject to the approval of the National Institute of Water Resources and of the Ministry of Public Health.
- The total or partial extraction of water from a reservoir for the culture of fish requires the approval of both the National Institute of Water Resources and the resident manager of the reservoir.

Regarding the import of aquatic species into the country, the importer must apply for the required authorization at the Import/Export Veterinary Services Department of the National Veterinary Medicine Institute, providing the following information:

- species to be introduced;
- quantity;
- origin (establishment and country);
- exporter;
- destination;
- purpose of the introduction;
- conditions and location of the quarantine facility where the organisms are to be kept;
- representative of the Ministry for the Fishing Industry, responsible for the quarantine supervision.

An additional document regarding ecological, genetic and health issues must be submitted to the Board of the Ministry of the Fishing Industry and to the Environmental Agency. The Resolution specifies the health certificates that have to be presented and establishes the corresponding conditions for the quarantine period. The Ministry of Science, Technology and the Environment is responsible for monitoring the introduction of new species and species falling under specific regulations (i.e. CITES).

According to the Decree-Law on Biosafety (1999), the Ministry of Science, Technology and the Environment, along with the National Centre for Biosafety, will grant, suspend or revoke authorizations concerning activities related to genetically modified organisms (GMOs). The Resolution for granting Biosafety Authorizations (2000) issues three types of authorizations, depending on the potential biological risk to workers, the community and the environment. These are the Biosafety License, the Biosafety Permit and the Notification.

The control of diseases is regulated by two main legislations. These are the Decree-Law No.54 on Basic Health Provisions (1982) and the Decree-Law on Veterinary Medicine (1993). Aquatic animals are not specifically mentioned in either. The Fisheries Regulation states that the Ministry of the Fishing Industry, jointly with the Veterinary Medicine Institute, shall issue health regulations to prevent the introduction of diseases into the country that might affect aquatic resources. It should also establish animal health surveillance systems and other measures pertaining aquatic health.

The Resolution on Hygienic and Sanitary Regulations establishes the relevant measures to be complied with by any aquaculture facility in order to prevent the occurrence and spread of diseases. Every establishment must do the following:

- apply for import and export authorizations;
- comply with the specific technical rules to prevent the introduction and proliferation of diseases;
- systematically monitor the aquatic population to look for potential pathogens;
- hold the required health certificates issued by the concerned Laboratory of Aquaculture Health of the Fisheries Research Centre or by any authorized laboratory;
- comply with the OIE Code (International Animal Health Organization – International Office for Epizootics);

- apply the Animal Health Surveillance System of the Veterinary Medicine Institute;
- hire qualified staff to ensure an adequate sanitary management.

Sanctions

Article 20 establishes that the authority may guarantee the protection of the environment by a series of means, including the cancellation or suspension of the environmental license. (Resolution No. 77/99 Regulatory Framework of the Process of the Environmental Impact Assessment, Ministry of Science, Technology and Environment).

Article 26 of the Law of the Environment indicates that the programmes, projects or activities that do not have an environmental license, or projects that do not comply with the demands and controls that are mandated by the environmental authority, may be temporarily suspended or confiscated completely by the Ministry of Science, Technology and Environment.

Citizen participation

The environmental authorities must establish, during the process of the Environmental Impact Assessment, the pertinent consultations with organizations of the Central Administration of the State, which are responsible for the management of natural resources. Such consultations must be answered within 15 working days. In case of no response, the approval of the corresponding measures will be effective, so that the interests and concerns of the communities and citizens in general are taken into account.

ECUADOR

Environmental legal framework

State environmental institutions in Ecuador are part of the National Decentralized System of Environmental Management. These institutions are subordinated to the mandate and regulations established by the National Council for Sustainable Development, which in turn form the System for Environmental Management (SUMA, its acronym in Spanish). SUMA is integrated by the National Environmental Authority (AAN, its acronym in Spanish); the Environmental Application Authority (AAA, its acronym in Spanish), the Environmentally Responsible Reinforcement Authority (AAAr, its acronym in Spanish) and the Environmental Cooperative Application Authority (AAAc, its acronym in Spanish).

This system constitutes a trans-sector coordination, integration and cooperation mechanism among the different instances dealing with environmental and natural resource management. The scope and competency of the SUMA are mandated by the Law of Environmental Management (Law No. 99-37, 1992).

Article 8 of the Law of Environmental Management establishes that the National Environmental Authority (AAN) is the Ministry of the Environment (MINA, its acronym in Spanish). This is the official governing, coordinating and regulating entity of the National Decentralized System for Environmental Management. However, some aspects are dealt with by other government agencies. Article 20 of this Law, states that the person with the intention to start a project likely to generate an environmental impact, must obtain an environmental license from the MINA.

The only specific provisions concerning aquaculture are found in the General Fisheries Regulation and Fisheries Development Law, which states that the granting of authorizations for aquaculture in the Ecuadorian Highlands using groundwater sources, is subject to EIA and evaluation by the Environmental Management Commission (*Comisión de Gestión Ambiental*).

Following the approval of the Environmental Impact Study, an environmental license must be issued by the Ministry of the Environment within seven days of the application date. Applicants must pay an annual insurance policy equivalent to USD 3 000, for each hectare of surface area open to production. The development of shrimp farming prompted some of the current environmental measures (Griffith and Schwarz, 1999; Chamberlain, 2002).

Obligation of compliance

Article 22 of the Law of Environmental Management states that projects that have been the subject of an EIA or have been granted an environmental license, should be selected at random for periodical inspection so that, if needed, corrective measures can be introduced in a timely manner. This evaluation is carried out through an environmental auditing, practiced by qualified consultants registered and authorized by the MINA.

The official entity responsible for EIA evaluation of aquaculture projects is the General Administrator´s Office of the Government of Ecuador. This entity is responsible for procedures and approval of technical studies and Environmental Impact Assessments, thus concluding on their objectiveness and validity in accordance with the environmental legislation.

The project promoter may hire independent consultants to carry out the EIA or auditing. Additionally, article 26 of the Law of the Environment indicates that the contracts contained in Environmental Impact Assessments, must include the specifications, parameters, variables and characteristics of these studies and will establish the obligation of applicants for preventing or mitigating environmental impacts.

Sanctions

Article 45 of the Law of Environmental Management establishes sanctions in case the project owner does not comply with the regulatory measures. Such sanctions are specified by the National Health Code (Chapter II of Title I, Book II).

Related “soft laws”

In 2001, a new certification standard for organic shrimp farming was formulated in coordination with farmers, importers, the Naturland Association (German-based certifier of organic products) and the GTZ (German Technical Cooperation Institution – *Deutsche Gesellschaft für Technische Zusammenarbeit*). Currently, only five farms produce shrimps according to these standards. An accredited independent third-party certification body is responsible for assessing compliance with Naturland’s eco label.

Citizen participation

The Law of Environmental Management establishes that every person or institution has the right to be informed promptly and properly about any activity of the State institutions that, in accordance with this Law, may produce environmental impacts.

HONDURAS

Environmental legal framework

The General Law of the Environment (Law 104/93) mandates the Secretariat of the Environment to coordinate and regulate the National Environmental Impact Assessment Evaluation System (SINEIA, its acronym in Spanish). Such a system is specifically constituted by all actors involved in a given project, namely the promoter, the Secretariat of the Environment; the Environmental Units (regional or local governmental offices dealing with environmental issues); the Environmental Protection Agency of the country; citizens and NGOs that express concerns about the development of the project and, when appropriate, a scientific committee (academics and members of professional associations appointed by the Secretariat of the Environment, according to their field of expertise, to provide technical advice).

The Environmental Evaluation and Control Directorate (DECA, its acronym in Spanish), as part of the Secretariat of the Environment, coordinates the SINEIA.

The Regulatory framework of the National Environmental Impact Assessment System, in its Article 5 stipulates that the EIA is an instrument that will be used for the prevention of potential negative effects on the environment. Such an instrument also dictates the need for all projects potentially harmful to the environment to obtain an environmental license form the Secretariat of the Environment.

An official classification of projects issued by the Secretariat of the Environment through Resolution 635/2003 defines, depending on their nature and magnitude, a numerical categorization for project licensing:

- Category one corresponds to activities with the least impact which, after analysis of their technical documentation, are granted an *Environmental Registration Number*.
- Category 2 corresponds to projects with higher but predictable impacts that can be mitigated through standardized approaches. These require an environmental diagnostic of the project site and are granted an *Environmental Authorization*, which contains a signed agreement by the requesting party, to comply with the mitigating strategies stated in the resolution.
- Category 3 is reserved for projects with the highest potential impacts on the environment that can be mitigated through tough measures of control. They have to submit an EIA and, if approved, are granted an *Environmental License.*
- There is a special category (4) reserved for high environmental risk projects, which cannot be approved under any circumstance.

Consequently, the technical and administrative requisites that have to be fulfilled by project promoters in order to get the corresponding permit from the environmental authorities, depends on the category. Aquaculture projects are classified as indicated in Table 1.

TABLE 1
Environmental classification of aquaculture projects by the Secretariat of the Environment of Honduras

Type of project	Category 1 (Environmental registration)	Category 2 (Environmental authorization)	Category 3 (Environmental license)
Pond fish culture	<1- ≤ 5 ha	>5 - ≤ 10 ha	> 10 ha
Cage fish culture	-	≤ 0.25 ha	≥ 0.25 ha
Shrimp farming	-	≤ 5 ha	≥ 5 ha

Source: Secretariat of the Environment, Honduras. Available at: www.serna.gob.hn/servicios/licencias_amb/tabla_cat/Paginas/default.aspx

Sanctions

Article 76 establishes two types of offences against SINEIA: starting a project without having the corresponding environmental license; and not complying with the mitigation measures or what is established in the Environmental Monitoring and Control Plan. This includes altering the results or deliberately omitting information that could lead to a biased environmental assessment. The Secretariat of the Environment will decide the corresponding sanctions, according to Environmental Law, its regulations and other applicable laws *(Regulation of the National Environmental Impact Assessment System. 1993).*

Citizen participation

The Law of the Environment establishes that the general public and NGOs may express their doubts, complaints and suggestions to the Secretary of the Environment, regarding a given EIA. The Secretary must then establish the time frame and process for the reception of such comments and it may include these observations in the terms of reference section of the study. The authority will inform the interested parties if their observations where taken into account.

Article 60 establishes that once the EIA report is submitted to the environmental authorities, the applicant must publicly notify it by using the major national newspapers and even radio stations.

MEXICO

Environmental legal framework

The legal framework that derives from the National Environmental Policy of Mexico, is the General Law for the Ecological Balance and Environmental Protection (LGEEPA, its acronym in Spanish), formulated and enacted in 1988. Its operational instrument to regulate environmental impact assessments is the code No. 30-05-00. The governmental entity responsible for technical assessment and authorization of any operation license for aquaculture projects, is the Secretariat for Natural Resources and the Environment (SEMARNAT, its acronym in Spanish), through its state representation offices (SRO). The technical analysis of aquaculture projects is carried out, in many instances, in coordination with the National Fisheries and Aquaculture Commission (CONAPESCA, its acronym in Spanish), which is the ultimate aquaculture authority of the country.

On July 2007, the General Law for Sustainable Fisheries and Aquaculture was enacted. Among its major instruments for fostering an environmentally responsible aquaculture industry are: the creation of the National Aquaculture "Chart" (CAN, its acronym in Spanish); the creation of Aquaculture Management Units (UMAs, its acronym in Spanish) and the legal obligation to formulate aquaculture territorial management plans (POAs, its acronym in Spanish).

The CAN is an annually-revised, comprehensive, technical and geographic aquaculture chart, which contains relevant information on the national inventory of aquaculture species and their culture systems; the territorial aquaculture zoning with information on the regional potential as well as the applicable regulatory framework in relation to the environment, and that of aquaculture sanitary and farmed fish food products safety measures.

As far as the UMAs are concerned, these are geographic micro to meso-regions whose environmental characteristics and species cultured are similar. Specific management plans are formulated for each UMA which contain the following elements:

- short, mid and long term aquaculture development plans within the context of the overall regional development plans;
- the actual carrying capacity of major waterbodies where aquaculture is to be developed or expanded;
- the geographic characteristics of the region;
- both the existing and planned basic infrastructure associated with aquaculture development;
- organization and participation mechanisms that ensure the inclusion of all stakeholders in aquaculture development plans;
- environmental protection measures and compliance with the applicable environmental legal framework;
- foreseen regional or local aquaculture sanitary actions;
- health and environmental hazards prevention programme.

The Aquaculture Territorial Management Plans have to be aligned with the National Ecological Territorial Management Plan, as well as to the corresponding State Ecological territorial Management and the Integrated Coastal Zone Management Plans.

All the above are legal instruments that influence the decisions regarding the approval or rejection of an environmental license and the actual aquaculture permit for a given project.

Aquaculture Projects Registration Procedure

Depending on the magnitude, location, water source and species to be cultured, an aquaculture project may or may not officially require an EIA in Mexico. Yet, all new aquaculture project promoters are required to formulate a thorough technical description of the project (hereafter referred to as the project technical file or PTF), including its exact location, water source and volume, farm dimensions and infrastructure, species and culture system, source of seed and expected production volumes and crop schedule. The PTF can be formulated and presented directly by the project owner, that is, there is no need for an aquaculture technical expert to submit or sign a PTF.

Since CONAPESCA is an entity subordinate to the Secretariat of Agriculture, Livestock, Rural Development, Fisheries and Food (SAGARPA, its acronym in Spanish), the PTF is submitted to the Aquaculture Department of the corresponding State Representation Office of SAGARPA, along with an application form to obtain a National Fisheries Registration Number and an aquaculture permit.

Checking for the need and type of EIA of an aquaculture project

It is mandatory for any aquaculture project promoter (this is a literal translation of the official term used by Mexican and all other Latin American countries´ environmental authorities, when referring to the person or company that requests an aquaculture project environmental license) to officially request the State Representation Office of SEMARNAT, to carry out a technical project site visit. Such a technical visit takes place within 20 days after the request has been submitted along with the PTF.

As a result of both the visit and the analysis of the PTF, SEMARNAT issues either an official request for an EIA if the magnitude and characteristics of the project require it, or an EIA-exemption authorization.

Other agencies involved in the process include the National Water Authority (CONAGUA, its acronym in Spanish), which is responsible for water management, thus granting permits for using surface and/or ground waters; the National Forest Commission (CONAFOR, its acronym in Spanish), since vegetation clearing for aquaculture projects requires a Technical Study of Land Use Change; and the National Service of Animal Health, Food Safety and Agri-foods Quality, or SENASICA, its acronym in Spanish, if the seed to be used is external and an in-farm quarantine facility is to be authorized (Figure 1).

Article 5 of the code 30-05-00, which is the actual operational instrument of the LGEEPA in its chapters R through U, specifies all activities related to aquaculture that need to be assessed for possible environmental impacts (Table 2).

SEMARNAT may, in addition to its own assessment, request the technical opinion of any entity of the Federal Government, or even consult external experts should it be required. In this case, the project promoter will be notified of the purposes of the consultation by SEMARNAT.

Depending on the magnitude, nature and consequently the potential geographical range of impact of the project, the EIA required by SEMARNAT can be categorized as "Particular" or "Regional". In general, aquaculture projects of more than 500 ha are required to submit a "Regional" EIA.

Where highly hazardous activities are involved, the EIA must include a risk analysis which contains preventive scenarios and possible mitigation measures.

If the project promoter makes modifications after the official authorization is issued, He must request a specific additional authorization from SEMARNAT for such

FIGURE 1

Schematic representation of all official environmental impact assessments and biosafety risks analysis followed by aquaculture project promoters in Mexico. (Note: environmental impact assessment is a responsibility of SEMARNAT. Numbers represent the approximate time period before the step of the procedure is finalized or resolved).

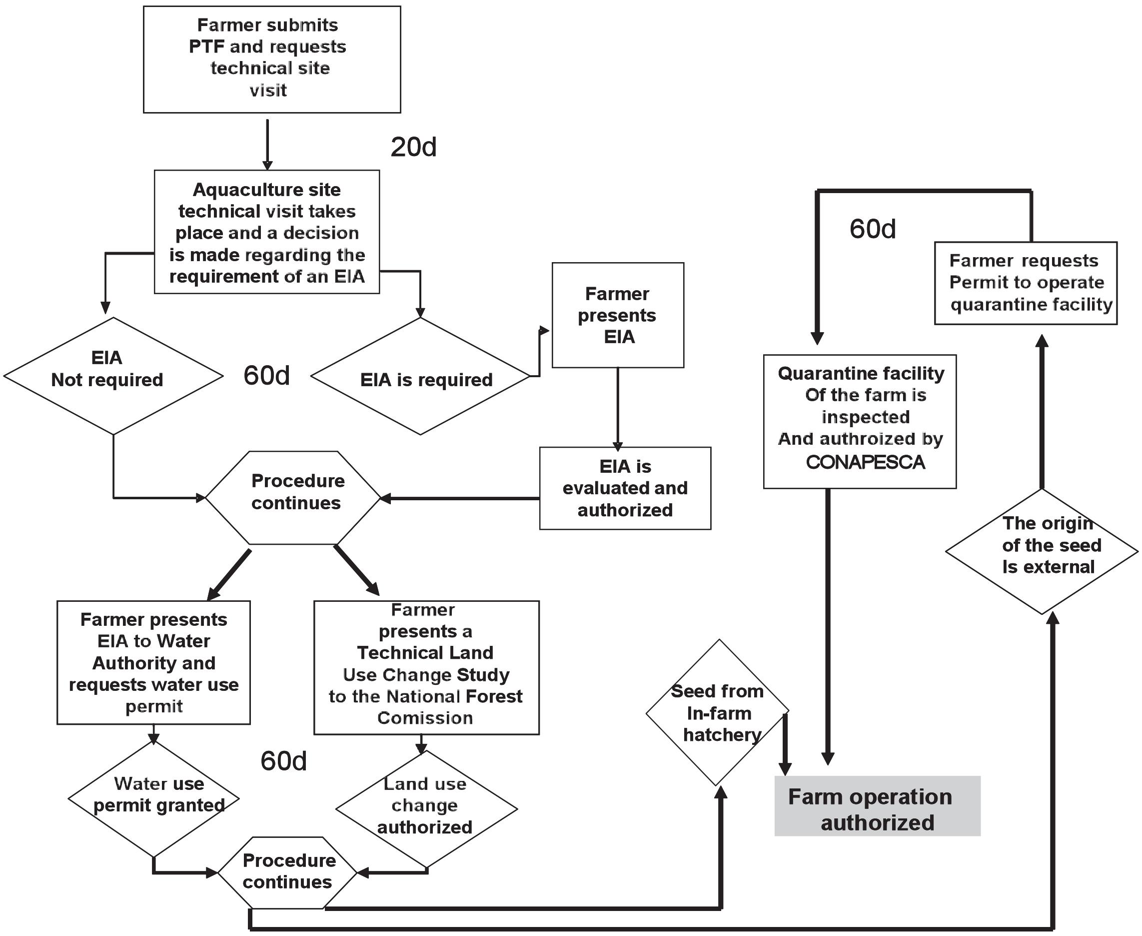

TABLE 2

Summary of zones and activities related to aquaculture for which an EIA is required in Mexico

Zone	Type of activity, infrastructure for which an EIA is mandatory	Chapter of the EIA Code 30-05-00
Mangrove areas, wetlands, coastal lagoons, lakes, rivers and littoral zones.	All anthropogenic activities except for self consumption fisheries and the construction of single family housing structures by native dwellers using local materials.	5-R
Protected Natural Zones	All anthropogenic activities except for self consumption fisheries and the construction of single family housing structures for native dwellers in buffer or peripheral zones.	5-S
Fish recruitment and nursery areas	Fishing activities in oceanic, coastal and inland waters that serve as recruitment and nursery areas dwelled by species under special protection.	5-T
Aquaculture operations in national waters or critical ecosystems	Construction and operation of aquaculture farms that involve the modification of habitats, use of common waters and discharge of wastewaters into natural waterbodies. Production of aquaculture seed in hatcheries, with the exception of species native to the ecosystem that becomes the water source and discharge point, and no chemicals are utilized. Seed production of exotic species. Placement of artificial reefs of any material.	5-U

changes. Depending on the nature of these modifications, a new EIA can be requested by the authority.

Finally, all Mexican states have enacted their own environmental legislation and many of them have a State Secretariat that deals with environmental protection. Furthermore, in states where aquaculture is one of the most important economic activities, such as the State of Sonora, a specific aquaculture law has been enacted. According to the LGEEPA, states have the authority to also request an EIA, in coordination with municipalities, whenever an activity or project is likely to affect local areas that are not exclusively reserved to the assessment of the federal government.

Additional permits required by aquaculture projects in coastal and marine areas

If the aquaculture facility is to be located on the coastal fringe or in open marine waters, a request for a coastal land use concession has to be made in the first case or, in the latter case, the EIA and its corresponding resolution issued by SEMARNAT, have to be presented and approved by the Secretariat of the Navy (SEDEMAR, its acronym in Spanish), which in turn revises it according to the Regulatory Framework to Prevent and Control Marine Pollution Caused by Wastes and Spills Act.

Related "soft laws"

CONAPESCA has stimulated the creation of regional and national systems which integrate all elements of both production and commercial chains for a given aquaculture product. These are called "product-systems". The most important aquaculture species of the country (shrimp, tilapia, carp, rainbow trout and oysters) have a product-system.

The National Service of Animal Health, Food Safety and Agri-foods Quality, is the official agency responsible for certifying that aquaculture products are cultured employing good management practices, processed under strict sanitary conditions and are safe for human consumption.

This agency has developed a series of best management practices manuals (BMPM) for both culturing a number of species and processing aquaculture products. These manuals are aligned with international standards and are intended to improve the sustainability of aquaculture projects, as well as maintain the quality and safety of aquaculture food products (Plate No. 1)

It is through product-systems and voluntary certification programmes that environmentally sound aquaculture practices and BMP codes are being agreed and introduced by farmers associations. Although not mandatory within the national legal framework, failure to comply with such codes could leave farmers out of the export chain.

Some state aquaculture agencies (i.e. the State of Sonora Institute of Aquaculture), as well as some aquaculture farmers organizations, in particular shrimp farmers, have

PLATE No.1

Examples of Best Management Practices Manuals for rainbow trout culture, molluscs culture and fishery and aquaculture processing, published by SENASICA

developed their own codes of conduct for responsible aquaculture practices, which are being intensively stimulated and are gradually being incorporated into the Mexican states legal frameworks (Alvarez and Avilés, 1995; Alvarez, 2000).

Citizen Participation

The Secretariat (SEMARNAT) publishes a weekly list of all authorizations (licenses) granted, including those pertaining to aquaculture projects. Recently enacted laws of transparency and access to information, allow any Mexican to get access to and consult all information regarding EIA and environmental licensing, unless specifically requested by the project promoter, upon demonstration that disclosure of his project information could affect industrial property rights.

The Mexican environmental framework also includes the participation of Regional Sustainable Development Councils. These are constituted by representatives of all sectors of society, namely chambers of commerce; non-governmental organizations (NGOs); academics; farmers associations; government officers and any other socially relevant group member. These Councils are consulting groups and might intervene in the decision of granting environmental licenses or aquaculture permits if asked by the corresponding authorities.

If the project is of a magnitude or nature such that public interests could be affected, a public hearing could be organized by the local environmental authorities, thus seeking a social consensus.

Checking the practice

MONITORING

As far as the actual follow-up of the environmental mitigation actions imposed by environmental authorities on aquaculture projects is concerned, in all of the countries reviewed, legal frameworks dictate that the project promoter is responsible not only for compliance of those actions, but also for timely informing of the authorities of every step taken in this direction.

Environmental laws in most countries state that the Environmental Impact Assessment should include a monitoring scheme either for impact mitigating actions or for early warning strategies (i.e. possible ecological disturbances of areas surrounding the project).

The regulatory framework of Brazil, Honduras and Mexico, establish general reference official norms, especially those related to wastewater discharges. Moreover Brazil and Mexico have specific norms to ensure that aquaculture practices are carried out with a minimum impact on the environment (Borghetti, Ostrensky and Borghetti, 2003).

In the case of Brazil this is through norms, while in Mexico it is through guidelines and in Colombia through the Environmental Management Plan. In the remaining countries (Honduras and Ecuador) no norms or regulations were found on the matter. Nevertheless, there is a possibility that the monitoring subject is stated in other instruments that were not found/analysed.

The process of environmental monitoring varies greatly from country to country. However, the lack of a standard that governs the sampling methodology appears to be a common denominator in the subject countries. All the people surveyed for this report mentioned that there are no methodologies specified by the authority. In some cases, there were some recommendations to take into account but there was no obligatory law to follow.

BRAZIL

The Environmental Impact Assessment of Aquaculture Projects

Environmental Impact Assessment Studies are drafted according to the following guidelines:

- consider different options for the development of the project (technology and location);
- identify and assess potential environmental impacts;
- define the project area of influence;
- consider governmental plans and programmes concerning the area of influence.

Moreover, the preparation of the study must at minimum involve the following activities:

- environmental diagnosis of the area of influence;

analysis of environmental impact of the project and alternative options;

mitigation measures;

- monitoring programme.

On the other hand, Environmental Impact Reports (RIMAs) contains at minimum:

- project objectives and justifications;
- description of project and alternative options;

- summary of results of environmental diagnosis of the area of influence;
- description of probable environmental effects on the area of influence;
- characterization of future environmental quality of the area;
- description of expected positive effects of mitigation measures;
- impact monitoring program;
- indication of recommended alternative option.

Environmental Impact Assessment and associated Report of Environmental Impact (EIA-RIMA) in Brazilian aquaculture can be undertaken individually at farm level or at local level through government strategies to plan and manage aquaculture development. Although Brazil has specific regulations about EIA, these are very broad and general and encompass all potentially impacting activities. They do not contain specific criteria or environmental assessment applied to aquaculture. In spite of this, aquaculture EIA procedures can be found on state and federal regulations to obtain an environmental license to aquaculture.

At individual level, investors that want to develop aquaculture on federal waterbodies (i.e. exclusive economic zone – EEZ, federal rivers and hydroelectric reservoirs) must submit an application according to the Decree n° 4.895/2003, which regulates the use of federal waterbodies to aquaculture, and the Inter-ministerial Normative Instruction (INI) n° 6/2004, which sets complementary norms, provide the application forms and details the procedures to obtain an aquaculture lease permit. INI n° 6/2004 sets the requirements for different classes of aquaculture projects, including research projects, demonstration units for training purposes, commercial aquaculture and areas for allocation of multiple farmers, called aquaculture parks. Aquaculture parks are defined on Decree n° 4.895/2003 as "Continuous physical space on aquatic environment, which encompasses a set of aquaculture areas and where other activities compatible with aquaculture can also be realized." These two regulations also foresee the delimitation of preferential areas for small-scale aquaculture, defined in the same decree as "Areas where allocation priority will be given to traditional communities attended by social inclusion programs".

Any change in the condition of the project or permanent data must be communicated within 60 days to the competent SEAP State Office, attaching the relevant documentation. Furthermore, when the change consists of the incorporation of a new aquaculture unit, the application shall be filed with the SEAP Office of the state where the activity is established. This procedure is required for verification purposes and to either update the original registration or issue a new registration certificate.

For federal waterbodies, proponents of aquaculture areas and aquaculture parks projects must answer a number of items in order to obtain an environmental license, as summarized below:

Methods employed for EIA of aquaculture projects

There are no specific methodologies but the EIA must include: project characterization, evaluate the potential impacts of farm residues on local water quality, propose mitigation actions for each potential impact, provide environmental diagnostic, prognostic and strategies for control, compensate and mitigate impacts.

EIA report and its follow up

Project characterization

There must be a site selection justification, social and economic analysis, evaluation of alternative technology and siting, and proponent opinion about environmental issues and the possibility of non-realization of the project.

Technical characterization should include description and quantification of farming structures, justification of their distribution, information about project work force, stocking densities, feeding practices, feed conversion ratio, mechanisms to avoid feed dispersal, farm management and operation, harvest procedures, control of escapes when farming exotic aquatic species, and environmental control program. For the latter, proponents must inform where the water sampling points will be and which parameters will be monitored, with their limits and description of analysis procedures.

Evaluate the potential impacts of farm residues on local water quality and propose mitigation actions for each potential impact.
Evaluate regional effects, with an analysis of their relation to governmental programs and aquaculture legislation for the region. Evaluate project compatibility with federal and state coastal management programs, reservoirs conservation programs and with the needs of other aquatic resource users.

Environmental diagnostic
This should include; definition and characterization of project surrounding areas, with information about water level amplitude for freshwater reservoirs and tide range for marine or estuarine areas, identification of potential pollutant activities that may affect the quality of water used in aquaculture.

There should be analysis of possible interactions, synergic and cumulative impacts with other aquaculture projects already installed in the same waterbody. For freshwater aquaculture an analysis of carrying capacity of the aquatic resource for aquaculture development should be undertaken.

Description of climatic conditions, aquatic resources, hydrodynamic processes and water quality, with measurements of the following parameters: pH, temperature, salinity, turbidity, dissolved oxygen, phosphate, nitrogenous compounds, oxygen biochemical demand, chlorophyll a, total and fecal coliforms.

Biota characterization with information about aquatic and terrestrial fauna, presence of exotic species introduced or established in the waterbody, description of phytoplankton community, information about endemic and endangered aquatic species and identification of environmental conservation units present in the region.

Socioeconomic characterization of the area influenced by the project, identifying rural and urban areas, navigation routes and tourism and leisure areas, fishing grounds, use and occupation of surrounding land areas.

Environmental prognostic
This component includes: evaluation of positive and negative impacts, their intensity and duration, stating if they are permanent or cyclic, reversible or non-reversible, local or regional. Impacts must be identified, measured and evaluated for the setup, operational and decommissioning phases of the project, and must cover physical, biological and socioeconomic issues.

Strategies for control, compensation and mitigation of impacts
Based on the environmental prognostic, proponents must describe actions and management practices that will be adopted to minimize or eliminate the negative impacts during the different project phases, with clear definition of tasks and responsibilities. Such strategies should also encompass environmental monitoring programs for water quality and other aspects when necessary.

Law Enforcement

The Brazilian constitution establishes in article 225, section VII, 3, that people or companies that engage in projects or activities considered harmful to the environment, will be subject to penal and administrative penalties. Those found to be causing harm will be obliged to compensate for the damages caused. (*Constitution of the Federal Republic of Brazil, 5 October 1998).*

Difficulties, constraints and some opportunities

The Special Secretariat for Fisheries and Aquaculture in Brazil (SEAP) created a National System for the Authorization of Aquaculture in Union Waters (Sistema de Informação das Autorização de Uso das Águas de Domínio da União para Aqüicultura - SINAU) using GIS to manage the concession of aquaculture areas in federal waterbodies (http://200.198.202.145/seap/sinau_web/html2/index_intro.html).

So far, 1 357 applications for aquaculture projects have been analysed – 652 for marine and 704 for inland aquaculture. By July 2008, only two individual proposals (0.01 percent) were approved by all authorities involved in the analysis process. This low approval rate demonstrates the enormous difficulty in the access to natural resources by small-scale farmers. Another 16 proposals of aquaculture demonstration units obtained permission for installation; however, the application process for demonstration units follows simplified analysis and does not require an environmental license to be issued.

On the other hand, the Ministry of Fisheries and Aquaculture in Brazil is currently making significant investments on aquaculture planning to demarcate aquaculture parks in federal hydroelectric reservoirs and coastal areas. This should facilitate access by aquaculture farmers to inland and coastal waterbodies, and at the same time ensure better analysis of the cumulative and additive impacts of multiple aquaculture farms located in the same area. Six parks are already approved.

There is a specific regulation to guide the elaboration of studies to demarcate marine aquaculture parks. The Normative Instruction n° 17/2005 sets the criteria and procedures for the elaboration and approval of Local Plans for Marine Aquaculture Development (*Planos Locais de Desenvolvimento da Maricultura – PLDM*), in order to delimitate coastal aquaculture parks and preferential areas for traditional communities. Normative Instruction n° 11/2008 provides some improvement on the guidelines for the PLDM elaboration, with more guidance on GIS products that must be developed in the plan, and procedures to select suitable areas for the aquaculture parks. The process begins with a strategic environmental analysis at local level, with the identification and localization of environmental reserves, review of users of coastal resources (navigation, leisure, tourism and fishery grounds), detailed environmental characterization of selected marine areas and surrounding land activities that might negatively impact aquaculture development, logistic consideration and biological requirements of target aquaculture species. Once elaborated, draft versions of the PLDM are discussed at state and local committees with participants from the environmental agencies, navy, universities, fishermen and aquaculture organizations, extension agencies and NGOs. A similar approach is used in the demarcation of inland aquaculture parks, although there is no specific regulation as for the PLDM for marine areas.

For inland aquaculture, the main hydroelectric reservoirs have been the object of studies to demarcate aquaculture parks (Plate 2). These studies include carrying capacity analysis according to the method proposed by Dillon and Rigler (1974) adapted by Beveridge (1987). The method requires information about Phosphorous content on feed and fish body, food conversion ratio, sedimentation rate and residence time to calculate the sustainable stocking density of each reservoir. The planning process also includes the development of a GIS for the selection of suitable areas and demarcation of aquaculture parks. An example of GIS developed for one major hydroelectric reservoir can be viewed at http://ecologia.icb.ufmg.br/~rpcoelho/Parques_Aquicolas/website/index.htm or http://200.145.243.69/parqueaquicola/index.php. Table 3 shows the total area of the six main reservoirs, the estimated carrying capacity for tilapia production, number and area of demarcated aquaculture parks and some social and economic indicators.

For coastal aquaculture, the planning and management process through the PLDM is under development in 11 states and 77 municipalities along the Brazilian coastline.

PLATE 2
Six main Brazilian inland reservoirs with demarcated aquaculture parks.

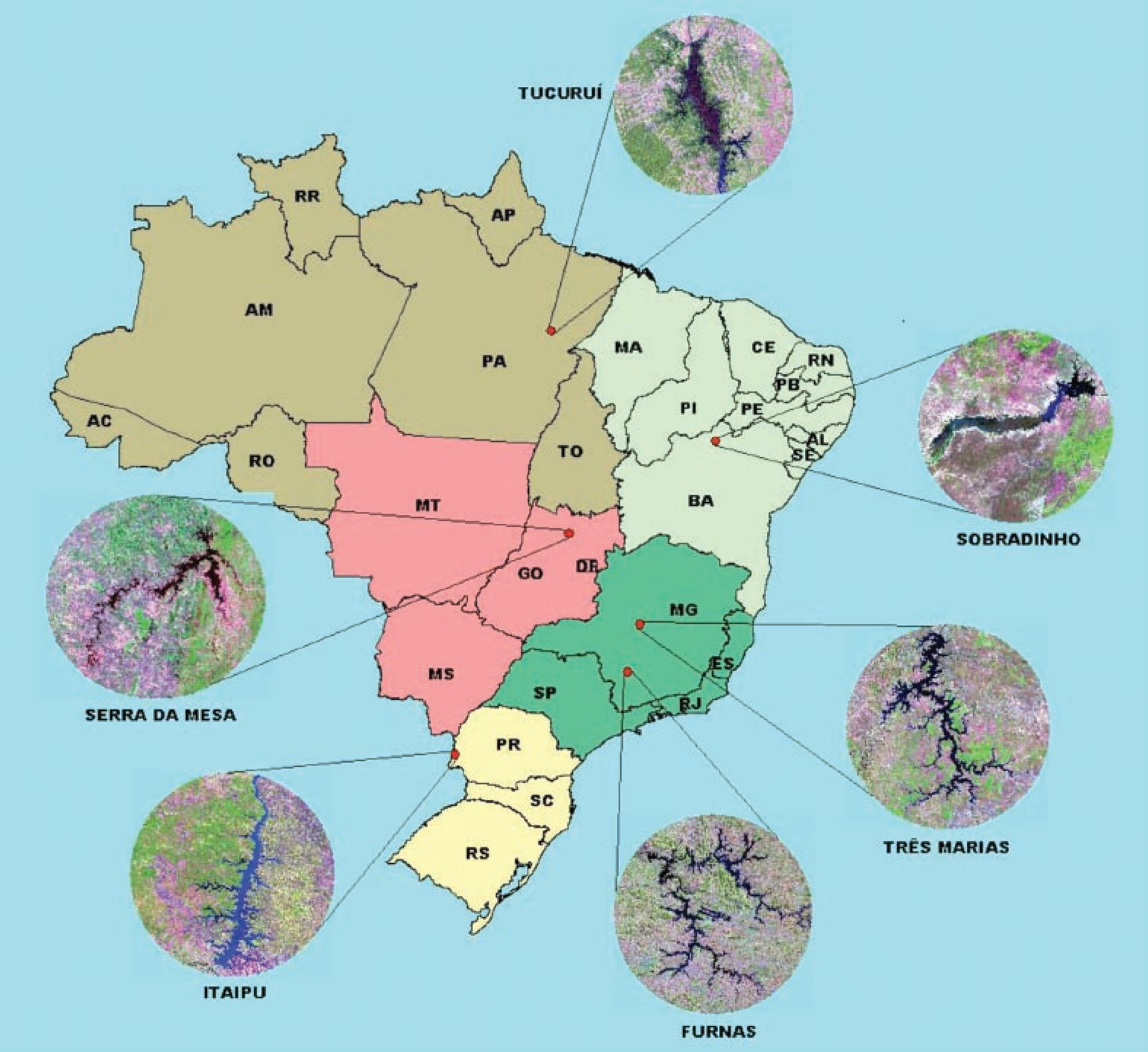

TABLE 3
Total area of the six main reservoirs, the estimated carrying capacity for tilapia production, number and area of demarcated aquaculture parks and some social-economic indicators

Reservoir name	Total area (km^2)	Carrying capacity (Tons)	Aquaculture Parks	Aquaculture parks area (ha)	Families attended	Direct employments
Furnas	1 440	79 269	16	3 087	9 896	39 586
Ilha Solteira	1 195	104 105	14	1 813	8 996	35 986
Três Marias	1 090	55 875	5	3 040	5 630	22 520
Castanhão	320	32 000	3	7 307	3 224	12 896
Itaipu	1 350	6 038	3	11 289	608	2 432
Tucuruí	1 165	14 753	4	7 000	1 117	4 468
Total	6 560	288 380	45	33 547	29 471	117 888

The first PLDM approved, at Santa Catarina state, demarcated 36 000 ha of marine aquaculture parks with 2 420 ha of production areas for bivalves and seaweeds. These parks will regularize 800 aquaculture farmers already in operation and also plan the allocation of further production areas for 2 585 new farmers. Estimated direct and indirect employment generated with this action are 7 740 and 31 000 respectively. The GIS developed for the PLDM in Santa Catarina can be viewed at www.arcims.ciram.com.br/epagri/.

The demarcation process of marine aquaculture parks through the PLDM involves at least two public hearings at each municipality. There is also strong public participation through the state and local committees. Granting of an individual lease permit in federal waterbodies involves a public tender process with ample publicity before the area is allocated to the investor.

COLOMBIA

The Environmental Impact Assessment of Aquaculture Projects

The procedure for environmental licensing starts with an application that must be submitted to the Ministry of the Environment by the project promoter. The Ministry, in turn, determines if an environmental analysis of alternatives is needed. When required, this document must contain the following information:

- exact location of the project, its dimensions and approximate costs;
- general description of the project, providing information on the social and environmental conditions of the area of influence of the project;
- certificate from the Ministry of the Interior, stating that the project will be located in areas where there are no indigenous or Afro-American populations;
- the actual EIA.

The sections required for an EIA, are the following:

- project location;
- environmental management plan of the project;
- the biotic, abiotic and socioeconomic elements that may be negatively affected by the project;
- impact assessment;
- outline of the prevention, mitigation, correction and compensation plans proposed.

Environmental control and project follow-up

Control and follow-up of projects likely to generate environmental impacts is undertaken during all stages of a licensed project. The decisions of the environmental authority regarding unsustainable practices should be technically justified and must be adopted by the project promoter in a timely manner (Decree No. 1728, 6 August of 2002 by which is regulated the Title VII of the Law 99 of 1993 on Environmental Licensing).

In Colombia, aquaculture is not explicitly included in the regulatory framework of environmental impact studies, possibly due to the lesser surface area and production volume compared with agriculture or livestock. However, an environmental management plan established by regional environmental authorities, requests the producers to take a series of preventive measures such as the construction of septic wells to minimize solid and liquid wastes discharge into natural waterbodies and oxidation lagoons to avoid the escape of farmed fish.

The Colombian legislation demands farmers that use natural resources (i.e. water) to obtain a permit from the Autonomous Regional Corporation. Issue of the corresponding permit demands an environmental monitoring plan. The frequency of monitoring depends on the corporation; however, on average, it is done every six months both within the project (i.e. culture ponds) and in the area of influence of the project.

There are standardized methods that the environmental authority may request the producer to follow in monitoring physical, chemical and microbiological parameters. These have to be followed by the farmer and the corresponding reports have to be regularly sent to the environmental authorities. It is also requested that the monitoring process is carried out by certified laboratories.

CUBA

The Environmental Impact Assessment of Aquaculture Projects

Applications for an environmental license require the following information:

- macro location, including a certificate issued by the Institute of Physical Planning (*Instituto de Planificación Física*), when appropriate;
- micro location, including a copy of the site report issued by the Institute for Physical Planning;
- project surface area;
- detailed budget;
- general description of the natural and socioeconomic environment;
- quantitative and qualitative characterization of biotic and abiotic environments of the site;
- description of the feasible alternatives, if appropriate;
- description of the effluents and possible indices of pollution to be monitored;
- connection of the sanitary network to the nearest existing waste treatment system;
- technologies to be used and their contribution to "clean production";
- specifications regarding toxic chemical by-products and/or dangerous wastes;
- identification and description of the potential positive and negative environmental impact;
- prevention and mitigation measures for the identified environmental impacts;
- preventive measures for possible persisting effects at the end of the project;
- prevention measures for accidents;
- documentary evidences of the public hearing held to inform the community of the possible effects of the project;
- monitoring programme.

Within ten working days, the authority decides on each application. It can decide a) to grant a license, b) to request the presentation of an EIA within the following year, or c) to reject the application.

The decision as to whether the project requires the submission of an EIA or not, is based, among other things, on the criteria listed below:

- health risks for the community (effluents, waste and noise);
- negative effects on the quantity and quality of natural resources and on the integrity of the ecosystem;
- relocation of human communities, alteration of their life system or practices;
- proximity of the project to human communities, resources or protected areas that could be adversely affected and consequently affect the overall environmental value of the area;
- alteration of the scenic or tourism value of the area;
- alteration of monuments, sites with anthropological, archaeological or historical value and cultural heritage in general;
- public perception after public hearings;
- environmental solutions proposed.

Each EIA study must contain the following information:

- purpose of the project (i.e. social benefit, commercial, etc);
- feasible alternative projects;
- relationship between financial costs and environmental costs for each alternative option;
- characteristics and duration (i.e. temporary or permanent) of the potential effects on the environment, health and life quality of the community;
- prevention, mitigation and negative impact correction plan;
- characterization of the environment of the project area;

- conditions to ensure the sustainability of the natural resources used in the project;
- qualitative and quantitative description of the natural resources and other raw materials, as well as an estimate of effluents and emissions, if applicable;
- technologies to be used and their contribution to clean production if applicable;
- detailed description of the energy sources and an estimate of the demand;
- detailed programme of environmental surveillance and monitoring;
- evaluation of any possible negative impact outside the project area;
- description of contingency and risk assessment plans;
- measures established in case the project has to be abandoned;
- results of the public hearings held with local authorities and the community;
- an estimation of the probability of occurrence of the identified impacts.

Environmental monitoring of aquaculture farms

The Cuban legal framework does not explicitly oblige farmers to carry out environmental monitoring plans. However there are a number of instruments aimed at exhorting producers to comply with sustainable practices in their respective farms, the most important being the Environmental Strategy (ES), which is a Plan of Action elaborated at territorial, regional and sector levels. Fisheries authorities revise this plan of action annually and a State environmental inspection is carried out systematically to farmers to induce the compliance of the ES.

With regard to monitoring and control of environmental licensees in Cuba, article 14 of the Law of the Environment establishes that the Inspection and Environmental Control Centre is responsible for establishing and adopting specific methodologies for the process of environmental impact assessment. This organization acts as a law-enforcement body and provides control and assessment on the process of Environmental Impact Assessment through the Territorial Representation Offices (TRO´s) of the Ministry of Science, Technology and Environment. This entity also keeps the TRO´s informed on EIA resolutions, as stated by Decree 77/99.

ECUADOR

The Environmental Impact Assessment of Aquaculture Projects

The process begins with the notification to the Environmental Responsible Application Authority (AAAr) of the intent to develop a project. The AAAr will determine the following steps and ensure inter-institutional coordination. No specific reference is made to aquaculture in these laws. However, the Environmental Management Law requires that any activity entailing environmental risks is subject to environmental licensing and therefore to technical scrutiny.

The study must be prepared in accordance with the following guidelines:

1. presentation of the study (premises, objectives, scope, methodology, legal framework);
2. description of the project (structural, technical and managerial);
3. characterization of the area of influence;
4. environmental baseline (characterization of the physical, biotic, socio-economic and cultural environment prior to any modification);
5. detailed description of the alternative options to the project, if any;
6. comparison and environmental assessment of the alternative options (including option zero or no-project alternative);
7. technical and environmental justification of the selection of the best option;
8. identification and assessment of the environmental impacts of the selected option;
9. impact mitigation plan;

10. environmental management plan;
11. conclusions and recommendations;
12. bibliographical references;
13. annexes with maps and photographs;
14. name and credentials of the technical expert that drafted the study;
15. executive summary of the study.

Follow-up of EIA resolutions

In Ecuador, article 9 establishes that it is the Ministry of the Environment's responsibility to define a control and monitoring system for aquaculture projects, according to the norms and parameters to be followed as a result of environmental studies. Article 22 defines the environmental management system required for environmental impact assessments as well as the evaluation system for projects with an environmental license.

The actual evaluation of the degree of compliance of the environmental management plan approved for each aquaculture project is carried out through environmental audits practiced by independent consultants accredited by the Ministry of the Environment, in order to establish the corrective measures needed.

According to stakeholders surveyed in Ecuador, in reality, an obligatory environmental monitoring established by the environmental authorities for aquaculture projects that have been granted environmental licenses is non existent. There are neither norms nor procedures for environmental monitoring and the environmental authority only evaluates projects in the case of an environmental emergency or after social claims.

HONDURAS

The Environmental Impact Assessment of Aquaculture Projects

Projects classified as Category 3, require an EIA. The legal documents of the aquaculture company, a technical project description and an environmental diagnostic of the project site are submitted by the project promoter to the DECA, which undertakes a preliminary analysis.

DECA then summons the members of the SINEIA to formulate, collectively, specific terms of reference for the EIA. The EIA is carried out by independent consulting firms within a timeframe established in the corresponding terms of reference. Depending on the complexity and potential environmental risk posed by the project, DECA can also request the participation of the scientific committee of the SINEIA.

Once the terms of reference for the EIA are elaborated by the SINEIA, the project promoter is responsible for contracting an independent expert to carry out the EIA within the timeframe indicated by the authority.

The EIA final report is then submitted to the DECA for technical analysis in which the SINEIA might be involved. Depending on the nature of the project, public hearings can be requested in the terms of reference, and evidence of these are to be submitted along with the EIA final report.

Follow-up of EIA resolutions

Reference limits and intervals for key parameters that must be observed by the project promoter, are those stated in the official technical norms. Table 4 summarizes the two types of official technical norms that serve as reference points for aquaculture projects in the country.

Once the EIA is approved by the DECA, the environmental license is issued firstly for a period of one year, to ensure that all mitigation actions stipulated in the document of approval are complied with. After this period, if conditions are satisfied, the environmental license is renewed indefinitely but the project is subject to regular inspection.

TABLE 4
Official environmental technical norms that serve as frame of reference for aquaculture projects

Technical norms for wastewater discharges into natural waterbodies and into sewage systems	Parameters/ factors regulated of relevance to aquaculture projects	Observations
Water quality of wastewater discharged into natural waterbodies	Physical and chemical parameters, including DO; pH; temperature; TSS; TAN; TP; BOD; COD; heavy metals; PB; hydrocarbons; total coliforms load.	Given the general scope of the norms, maximum allowable limits of most parameters are much higher than the recommended for aquatic biota.
Technical norms for the use of wild fauna	Import/export authorizations; CITES certificates; collection of wild broodstock and/or juveniles.	Aquaculture is not explicitly mentioned in these norms, possibly because they derive from laws aimed at protected natural areas and sustainable use of forests.

Source: Secretariat of the Environment, Government of Honduras, available at: http://www.serna.gob.hn/institucional/legislacion/Documents/Normas%20Técnicas.pdf)

In Honduras, the Regulation of the National System of Environmental Impact Assessment establishes technical norms that serve as reference for the evaluation of projects and activities. Additionally, these technical norms are used as control mechanisms in technical audits. Article 71 of the Law of the Environment establishes that control and follow-up will be defined in the EIA resolution issued by the DECA and signed by the project promoter.

There may be an economic collateral deposit, usually required in cases of high environmental risk projects. This collateral might be required by the Secretariat of the Environment. This deposit is a condition for being granted the Environmental License *(Regulation of the National System of Environmental Impact Assessment 1993).*

MEXICO

The environmental impact assessment of aquaculture projects

According to Mexico´s Environmental Law (LGEEPA), the term "Environmental Impact Description" (MIA, in Spanish), is defined as …"*the technical document through which the potential environmental impacts of a given project are described, as well as the ways in which they can be mitigated..*". Hence, as a first approach, the PTF, along with the technical project site visit, are sufficient to determine whether an in-depth EIA is required for an aquaculture farm.

This same Law defines the term Environmental Impact Assessment, as "… *the procedure through which the Secretariat (SEMARNAT) analyses the potential environmental impacts, and imposes the conditions under which a given project is allowed to operate in order to ensure that no ecological disturbances occur, nor pre-established limits to prevent environmental deterioration, are surpassed…*" This of course applies to aquaculture projects, for which a number of specific activities are listed within the law.

Methods employed for EIA of aquaculture projects

There are no official methods imposed or followed by the Mexican environmental authorities regarding EIA of aquaculture projects. However, a series of specific guidelines for EIA are provided to farmers and consulting firms. The phases in which SEMARNAT divides the EIA are presented in Table 5.

Once an EIA requested by SEMARNAT is elaborated and submitted, standard qualitative analytical procedures are applied by the EIA evaluators. Basically the following methods are suggested and employed:

- cause-effect standard impact assessment matrix;
- successive impact matrices;
- reciprocal action matrix (Leopold Matrix);

TABLE 5
Elements, analysis and phases of an environmental impact assessment recognized by SEMARNAT, Mexico

Phase	Involves
1. Description of the project as well as the preliminary actions involved.	General description of the project and activities involved, including those that take place before the actual operation. Technical attributes and environmental risks should be emphasized.
2. Breakdown of the project in its principal components	This is a logic detailed description of the four conventional phases accepted by Mexican norms: site preparation, construction, operation and abandonment, identifying possible environmental impacts.
3. Description of the environmental state of the site prior to its modification (ecological baselines)	General description of the physical environment, including the biotic and abiotic components, based both on relevant literature and in situ direct observations. This phase includes a description of the social and economic dynamics of the site and region where the project is to be developed.
4. Identification of the most sensitive environmental features of the project site	This includes an analysis of the degree of disturbance of the project site, or the existence of pristine zones in the site´s potential influence range; diversity and uniqueness of biotic elements; critically important ecosystem areas (i.e. nursery areas). This is carried out employing a systemic approach.
5. Analysis of the possible influence of the project on other development or environmentally sensitive areas	This involves the cross-analysis of possible overlapping of the project and its influences on other development projects or environmentally protected areas that can be incompatible.
6. Impacts identification	This phase defines all possible repercussions of each of the activities involved, and on what elements of the environment. Each identified impact is quantified and finally all impacts quantified are added up to yield an overall measure of the environmental impact of the project as a whole.
7. Alternatives	If there are more than one technical or geographical alternative to the project, these are analysed and compared trying to balance their environmental impact and the actual needs of the project. The environmental criteria dictate the resolution.
8. Mitigation measures	The final report must include a series of practical measures whose adequate and timely application, should ensure the sustainability of the project.
9. Residual impacts valuation	Externalities are carefully identified in assessing the project. This applies to all negative side effects of the project that were overlooked over the previous phases.
10. Control plan	This last phase involves the formulation of a thorough follow-up plan that includes the critical parameters to be monitored, the monitoring frequency, as well as the adequate indices that measure the effectiveness of the mitigation plan.

- overlap method;
- Batelle-Columbus Method (quantitative factor tree).

All these methods are recommended in the specific EIA guidelines for aquaculture projects, and the cross-application of all of them, constitutes the standard procedure for identification of possible impacts of aquaculture projects and decision-making. Some of the concepts included in EIA matrices, are presented in Table 6.

The EIA report and its follow-up

The actual resolution on the EIA presented by the project promoter usually includes a series of conditions aimed at mitigating the potential environmental impacts that were identified. These may include a wide range of considerations. Some examples include infrastructure modifications, strengthening biosafety measures, wastewater monitoring, recipient waterbodies ecological studies, potential predators control, etc.

The project promoter is thus obliged to strictly comply with such conditions. A copy of every EIA resolution is sent to the Environmental Protection Agency (PROFEPA, its acronym in Spanish), which is the entity with the legal responsibility of inspecting all project sites, to ensure that conditions stated in the EIA resolution are fulfilled.

Representation offices of SEMARNAT in every Mexican state, have the authority to assess and issue one of the following resolutions: a) a document stating that the aquaculture project does not require a further EIA and can thus operate if CONAGUA (the water authority) and CONAFOR (the Forest Commission) or any other governmental entity, have no technical or legal objections; b) the aquaculture

TABLE 6

Example of a standard Impact assessment matrix employed for the identification and estimation of the degree of magnitude of possible environmental impacts of aquaculture projects in Mexico. Each type of impact is categorized qualitatively as low, medium or high in magnitude

Activity	Impacts on physical resources	Impacts on ecological systems	Overall changes in the landscape	Social and economic aspects
Construction phase				
Vegetation clearing	Soil erosion; sedimentation; drainage and runoff; topography; surface and ground waters, etc	Habitat modification; biodiversity; ecological niches; migratory patterns; nursery areas, etc.	Overall aesthetic quality; social perception.	Net social costs and benefits for the community; health issues; employment; effects on the quality of life.
Operation phase				
Water exchange	Flooding; soil erosion; sedimentation.	Eutrophication of recipient waters; organic matter accumulation; changes in community structure.	Overall aesthetic quality; social perception; unpleasant odors.	Potential organic pollution of agricultural lands; potential availability of organic matter for fertilization of agricultural plots.
Closing down and abandonment of the project site				
Pond inter-connection	Flooding; runoff; drainage.	Habitat modification, migratory patterns; biodiversity; ecological niches.	Overall aesthetic quality; social perception; unpleasant odors.	Net social benefit of the creation of a wetland; health issues; access roads.

Source: H. Ricalde, SEMARNAT-Mexico, pers.comm. 2008

TABLE 7

Selection of official norms that have to be observed by aquaculture projects in Mexico

Norm code	Relates to	Factors/parameters included
NOM-ECOL-001-1996	Maximum allowable limits of physical and chemical parameters of wastewaters discharged into common use waters.	Water temperature; suspended solids; BOD5; Total Nitrogen; Total Phosphorus; heavy metals
NOM-059-SEMARNAT-2001	Native flora and fauna species protection; risk categories; criteria for inclusion/exclusion of species in the list of threatened or endangered species	List of species by category (threatened, endangered; subject to special protection).
NOM-062-SEMARNAT-1994	Strategies to mitigate the effects of land use change	Specifies a series of measures to prevent the total loss of vegetation cover around the project site
NOM-010-PESC-1993	Health requirements for imported aquaculture organisms	Health certification requirements for imported aquaculture organisms
NOM-011-PESC-1993	Norms to regulate quarantine periods and procedures for the import of live aquaculture organisms	Procedures to quarantine imported aquaculture organisms; specifications for in-farm quarantine areas; certifiable and notifiable diseases.
NOM-002-PESC-1993	Norms to regulate the capture of broodstock and postlarvae in waters of federal jurisdiction.	Procedures, season and marine zones for the capture of shrimp breeders and postlarvae.
NOM-EM-006-PESC-2004	Measures to prevent the dissemination of high impact diseases and the use of aquaculture antibiotics	Practical preventive measures to avoid epizootics. Lists of allowed and banned therapeuticals.

farm operation is authorized as long as mitigation strategies (stated in the document) are implemented and reported, or c) the project is not allowed to operate due to major environmental considerations.

There are a number of official norms (NOMs), as well as other instruments such as integrated territorial management plans and protected areas management plans, that determine both the maximum allowable limits of key physical and chemical parameters for aquaculture projects and the geographical limits for aquaculture projects. Table 7 presents a selection of official Mexican norms that have to be complied by aquaculture projects in Mexico.

Mitigating actions stated in the resolution may have to be made prior to, during and/or after the execution of the project, and a timeframe for the compliance of each of them is provided. In case of monitoring programmes (i.e. wastewater) a pre-established frequency is specified.

In all cases, the project promoter has the legal obligation to inform SEMARNAT within the timeframe stipulated in the resolution, about every mitigating action taken, and to produce a comprehensive report of the environmental monitoring programme requested by the authority. Failure to comply could lead to administrative (monetary) sanctions or might even be considered a criminal offence, depending on the magnitude of the potential negative effects.

The official standards for the environment and/or for fisheries and aquaculture (see Table 5 for examples) constitute legal references for preventing the disturbance of critical ecological processes, and hence become points of reference of EIA resolutions. Although many official aquaculture standards cover general aspects, the majority of them relate to the major aquaculture species, and in particular, to shrimp.

Law enforcement

The Federal Environmental Protection Agency randomly selects aquaculture projects that have been authorized by SEMARNAT to operate under mitigation conditions and carry out environmental auditing visits. Such site inspection visits are to ensure that all conditions are complied with in a timely manner. PROFEPA is the environmental law enforcement entity of the government and its authority includes the prosecution and sanctioning of project licensees that do not comply with EIA resolutions.

Difficulties and constraints

Despite gradual efforts to improve environmental law enforcement in Mexico, there are several drawbacks, especially in the field of aquaculture, which could be summarized as follows:

- PROFEPA, the environmental law enforcement entity of the Mexican government, has a critical shortage of trained staff to inspect aquaculture operations, many of which have been authorized to operate subject to mitigating measures.
- Many aquaculture projects, particularly those promoted by state or municipal governments, are treated with more flexible criteria than private projects, regardless of the environmental impacts detected. That is, social or political criteria are put above environmental protection.
- In order to foster aquaculture in many regions of the country, state governments have invested in basic infrastructure to create "aquaculture parks", many of which have overlooked environmental externalities that affect even the farms that constitute the park themselves. This also makes it difficult to identify and make individual farmers accountable for environmental degradation.
- The pace at which aquaculture is growing in the country is much faster than the capacity building of the Federal Government in terms of EIA in aquaculture, thus depending on external sources for analysis. This can generate conflicts of interests, since many independent experts or academics consulted, are the same consulted and hired by the industry.
- Mid-sized and small-scale aquaculture farmers lack the economic capacity to modify their culture facilities and/or biosafety infrastructure. Nor do they have the capacity to incorporate better management practices. This, on the one hand, prevents their farms from operating in a more environmentally sound manner and on the other hand, prevents them from getting integrated in commercial chains that demand BMP certification.
- Small-scale farmers do not usually approach the environmental authority and therefore do not formulate an EIA. They are not enforced to do so, given

their marginal individual contribution to the national aquaculture production. However, the sum of the production of all small-scale aquaculture farms, in some cases highly concentrated in localized areas, is significant and consequently worth environmental monitoring.
- In-depth environmental risk analysis tools are not commonly employed or demanded by the environmental authority, even though many aquaculture projects require it. Consequently most decisions are made on the basis of the general information requested by the EIA guidelines.

Checking the effectiveness

APPRAISAL OF EFFECTIVENESS OF EXISTING EIA AND MONITORING REQUIREMENTS AND PRACTICES

The present review shows that there is a growing recognition in Latin American States and societies of the importance of formulating legal frameworks that stimulate sustainable production practices in general and, in some countries, in the aquaculture sector in particular.

The creation of specific norms and EIA guidelines for aquaculture projects indeed are significant steps, considering that aquaculture was a sector excluded from national development plans and the environmental legislation of many aquaculture-producing countries of the region up until the late 1980s. Some of the worst environmental impacts caused by aquaculture in the region took place during this decade, as a result of governmental actions aimed at fostering export-oriented aquaculture farms in ecologically sensitive zones (e.g. mangrove ecosystems) due to the lack of a systemic vision of aquaculture as a natural resource user, and the lack of recognition of the importance of introducing environmentally sound, sustainable production strategies.

Environmental impact assessment for aquaculture projects has only been recently applied as a decision-making tool in many countries of Latin America. Important aquaculture regions (e.g. shrimp farming in Guayas Province, Ecuador and the coastal fringe of Northwestern states of Mexico) expanded rapidly over more than a decade since the early 1980s, without having to submit an EIA nor having a clear picture of ecological baselines prior to the construction of aquaculture farms.

In more recent years, many farms have been set up within those same aquaculture regions but only after obtaining an EIA-based permit conditioned to the compliance of tough environmental regulations.

The above makes it difficult to assess the effectiveness of the application of EIA and monitoring requirements, given the lack of ecological baselines in aquaculture regions prior to the establishment of aquaculture farms and prior to the legal obligation of EIAs and environmental monitoring systems. Consequently direct "before and after" comparison is difficult.

However, considering the perception of some aquaculture farmers, researchers and regulators in Brazil and Mexico[1] (second and third larger aquaculture producers of the region), there seems to be a consensus that EIA tools have been effective at:

- bringing together all stakeholders of the sector in a participatory approach to the environmental impact assessment of aquaculture projects;
- creating the need for environmental experts in aquaculture-oriented EIA tools;
- identifying the potential environmental impact of aquaculture projects;
- generating a precautionary approach for aquaculture development;
- gradually generating a public perception of aquaculture as an activity that can be practiced in a more sustainable manner.

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[1] Source: Telephone survey carried out to the following persons: M. Hipólito, aquaculture researcher at the Instituto Biológico, São Paulo, Brazil; O. Ribeiro; aquaculture researcher, Universidade Federal de Viçosa, Brazil; Hélio Guimarães, fish farmer, Aquahel, Ltda, MG, Brazil; M. Abraham, fish farmer, Acuícola Emmanuel, S.A., Yucatan, Mexico; R. Gonzalez, fish farmer, Yucatan, Mexico; H. Ricalde, officer responsible for EIA of aquaculture projects, SEMARNAT Representation Office in Yucatan, Mexico.

Some experts and stakeholders in the region (see Annex 1) perceive the EIA as another component of the country's bureaucratic burden and consequently they do not recognize its usefulness in real prevention of environmental impacts.

Some of the weak points of the EIA that regional experts identify are:

- unclear definition of the coverage and scope of the studies;
- lack of in-depth analysis results in a weak environmental management plan;
- lack of revision and evaluation mechanisms of both EIA and environmental monitoring;
- high tolerance of non-compliance by the existing regulatory mechanisms generates a lack of credibility in the system and impunity.

As far as the appropriateness of the EIA methods employed is concerned, both the guidelines and methods have in general been adopted from standard international methodologies such as the very early guidelines included in the US National Environmental Policy Act of 1970. Ever since then, multiple sector and activity-specific adaptations to the EIA (including aquaculture) have been made in all Latin American countries.

In general the type of information required by EIA guidelines and the methods employed are similar throughout the countries of the present review. Moreover, many international aid agencies (e.g. USAID) include EIA guidelines for Latin American countries; hence EIA terminology and assessment methods have become fairly standardized throughout the region and are familiar and common not only to regulators but to farmers themselves.

In countries where there are official environmental standards specific for aquaculture projects (i.e. Brazil, Mexico and Honduras), these are fairly general and sometimes meaningless within a particular geographic context, regardless of its aquaculture importance. For example, the upper limits stated in Honduran standards for wastewater discharges, are much higher than those generally recommended as safe to avoid eutrophication of natural waterbodies elsewhere.

Furthermore, there is no official mechanism for regular revision of these standards derived from systematic environmental monitoring of ecosystems affected by aquaculture practices. This makes the standards obsolete in many instances or out of context.

Even though there seems to be an increasing awareness by aquaculture farmers of the importance of EIA tools and monitoring systems, application of such requirements still appears to be more the result of law enforcement actions than a genuine environmental conscience of farmers. Hence data generated as a result of EIA is not fully utilized by farmers to the advantage of the sustainability of their projects, but rather as a way to comply with environmental regulations.

Direct participation of all stakeholders in the revision of the EIA and environmental monitoring legal frameworks is not common in the countries reviewed. However technical procedures, terms of reference for EIA and monitoring requirements for aquaculture projects, are elaborated by EIA systems that incorporate representatives of all stakeholders in countries like Honduras. No feedback mechanisms whereby farmers, environmental experts and regulators provide their views for improvement of EIA and monitoring requirements were identified in the countries reviewed.

However, there has been an increased demand by the general public to participate in the different stages of EIA and monitoring programmes of aquaculture projects. The increased participation contributes to the trustworthiness of the results, the viability of environmental decisions and to the transparency of the process.

Latin American governments have been creating opportunities specially intended for community participation in the process of environmental impact assessment projects, plans, programmes and policies. Some of them are:

- creation of specific participatory consultation committees in preliminary evaluations of projects in order to define the approach and scope of EIA studies;

- obligatory social participation plans during the elaboration of environmental studies;
- publication of both EIA studies and their results through mass media;
- public exposition of EIA results;
- legally established periods for communities to express opinions and make observations regarding projects in the process of obtaining environmental licenses.

In some countries like Mexico, citizen participation is fostered through the Regional Councils for Sustainable Development, where all stakeholders groups are represented and can have an influence on decision making with regard to project licensing or revocation.

In Brazil, the National Council for the Environment consists of official representatives, as well as the presidents of the national unions of Industry, Agriculture and Commerce, the National Union of Workers, the Brazilian Association of Sanitation Engineering, the Brazilian Foundation for the Conservation of Nature and two environmentalist NGOs. It is an organization that has critical functions with regard to the formulation of policies and norms. Also, the national Council of Hydrologic Resources is represented by users of water resources and sectors of the civil society. This council's principle function is to control the execution of the National Plan for the management of water resources.

In Colombia, the National Environmental Council promotes the participation of representatives of industry, NGOs and indigenous communities. Meanwhile, two NGO representatives hold seats in the Directive Councils of the regional independent corporations (the 33 environmental authorities at the regional level). Two seats on this council are presided by the private sector and two represent ethnic minorities. Six representatives of the local, regional and national governments are also a part of this council.

Suggesting possible improvements

LEGAL FRAMEWORKS

Generally speaking there seems to be a consistent and genuine response of Latin American governments to the demand made through international agreements (i.e. the Rio Summit) for adjusting and/or creating environmental legislation aimed at stimulating sustainable forms of production; introducing EIA tools and environmental monitoring systems; fostering environmental awareness of economic actors; and creating regulatory frameworks that facilitate law enforcement.

All of the countries reviewed possess environmental legislation that includes EIA as an analytical tool for decision-making regarding environmental licensing, although only Brazil, Ecuador and Mexico have specific guidelines for aquaculture projects.

There are only two countries, namely Brazil and Mexico that possess a specific fisheries and aquaculture law. This reflects the increasing importance of the aquaculture sector in these countries and the need for a specific regulatory framework. However, resource allocation for stimulating aquaculture growth and development is increasing, while financial and human resources allocated for the sustainable management of the sector by the government remain insufficient.

Some areas of opportunity detected as a result of the present review, are the following:

- There should be a pre-determined timeframe for the systematic revision of the environmental regulatory framework for aquaculture in every country, taking into consideration a) changes in the international legislation; b) growth rate of the activity within each country; c) changes in the ecological conditions of specific aquaculture regions; d) technological and scientific developments contributing to more sustainable methods of production; e) global and regional tendencies regarding BMP and environmental certification.
- Revision of the regulatory frameworks should be participatory, thus including all stakeholders within the sector.
- It would be wise to consider the creation of more specific (state or provincial) regulatory frameworks to respond to local environmental contexts and issues.
- All countries should create specific aquaculture standards as environmentally precautionary reference points, especially related to: water quality associated to wastewater; management of exotic species; use of prophylactics and of therapeutic drugs; quality of supplementary feeds and overall biosafety measures, among other aspects. Again it is important to take into consideration the national and regional contexts, to avoid generalizations.

Many governments of Latin American aquaculture-producing countries are being challenged by the pace at which the aquaculture industry is growing (15–30 percent per annum). This calls for an integrated vision of the sector, including the following aspects:

- Regional and subregional planning of aquaculture development, supported by research-based information on ecological baselines; aquaculture carrying capacity; meso and microregional geographic characterization in relation to species and systems of interests and regional and local land use.
- Capacity building of regulators in EIA of aquaculture projects, in particular in aquaculture regions, thus not having to depend on central environmental authorities for EIA. This will allow for a better understanding of the particular challenges of the sector and improve the dialogue with farmers.

- Decentralization of competencies in order to foster local decision-making in relation to environmental licensing, provided the technical capabilities of the staff have improved to match such a responsibility.
- Creation of systematic environmental monitoring programmes throughout coastal and inland ecosystems where aquaculture is present, in order to generate pertinent information in a timely manner for the sustainable management of the sector. These programmes should be included in the environmental legislation of each country.
- Identification of possible sustainability indicators and the ecological and production information required for their measurement, to incorporate them in the systematic monitoring programmes.
- Aquaculture authorities should encourage the creation of national and regional aquaculture development councils with the following objectives: a) to generate a common goal towards the sustainable development of the aquaculture sector among governments, NGOs, farmers, certifiers, environmental experts, etc b) to collectively monitor and share information on the development of global tendencies in more sustainable technologies, environmental certifications and international environmental legislation.
- Creation of national and regional (i.e. state, province, etc) environmental information systems for the aquaculture sector. This would involve specific databases fed with information derived from the environmental monitoring programmes and would eventually include the overall tendencies of sustainability indicators.

The aquaculture industry of the reviewed countries is based on high value species cultured for export markets. Analogous to other consolidated agriculture and livestock production sectors, a small percentage of the net revenues by export sales from aquaculture products could be channelled towards capacity building, environmental monitoring and the environmental information system. This could be a proposal emanated from the aquaculture development councils, thus including the agreement of aquaculture farmers.

Conclusions derived from the surveys indicate that one cause of the lack of effectiveness in monitoring is tied to the centralization of these processes and, in many cases, the lack of personnel in the governing institutions. In some other cases, a lack of execution capacity, lack of financial resources, dispersion of responsibilities in different institutions, forcing multiple tasks and a slowing down of the process are also significant factors.

Those surveyed relate the lack of follow-up and monitoring to budgetary problems and a lack of personnel at the institutions, distance of the sites, limited qualification of the existing personnel and the lack of standardized norms and procedures for monitoring. The little or reduced reliability of results and feedback is associated with the lack of standardization of methodologies for the collection of samples and analysis of the results, as well as the lack of systematization of the collected data.

According to those surveyed, the perception that exists amongst the producers is that the monitoring is not efficient because it is expensive and the results have little or no applicability. Additionally, the lack of education on these subjects is evident among the townships, which limits their effective participation.

In conclusion, we can say that in general abundant laws exist relating to the management of environmental impact. However, there is limited guidance and few standards relating to monitoring (methodology; frequency; qualifications). Without such standards, a legal base does not exist to ensure either the collection or the utility of the data. This means there is usually little basis for taking corrective measures where negative impacts occur. The problem is exacerbated by the lack of capacity in most countries to follow up and ensure compliance with any standards.

Furthermore, according to the surveys, there is limited correlation between the environmental problems and the requirement of monitoring, which in many cases causes the producers to view this as bureaucracy, as opposed to information required to solve or to prevent environmental problems.

Recommendations

Since ample environmental legislation exists in the subject countries, efforts should be focused on the development of operative technical instruments that ensure their success.

1. Economic instruments should be considered to stimulate the fulfillment of environmental norms and the application of follow up monitoring.
2. The processes involved in the decentralization of environmental management in this region should be deepened and oriented to organize monitoring systems that when coupled with shorter distances and increased relevance to the zone of study will prove more efficient.
3. A gradual increase in citizen participation should be promoted and reinforced through publicity, activities, and training. Priority should be given to local participants, for a greater and more efficient impact.
4. The countries involved in this study should combine higher level management to underpin ecosystem services with planning and management of administrative systems at the state level. This implies the development of joint work mechanisms between institutions at different levels, incorporating environmental criteria in regional decisions.
5. The governing institutions should develop a greater association with the agencies that define parameters, and they should obtain a more scientific analysis and interpretation of the data generated from monitoring. They should promote investigations that contribute to the solution of the problems, thus obtaining feedback directly from the participants as well as a reduction of costs and a more effective flow of relevant information.
6. Environmental management instruments such as guidelines and standards should be developed to promote consistency and efficiency. Standard methodologies and frequency of sample collection should be established, including to geo-referencing of sample stations.
7. Responsibilities and qualifications for monitoring should be clarified. Accreditation of ISO 17025 certified laboratories should be promoted to ensure the quality and trustworthiness the monitoring.
8. Governments should establish budgetary allocations sufficient to assure effective monitoring that contributes to improved environmental management and economic performance of the activity.
9. Reducing investment costs by focusing environmental impact studies on economic activities that represent a particular risk to the environment would also prove beneficial.
10. Develop processes in order to establish obligatory commitments and measures that derive from the results of monitoring.
11. The subject countries should assign resources and organize processes for human resources development. This would allow for more effective use of monitoring as a management instrument.

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ANNEX 1

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ANNEX 2

QUESTIONNAIRE ON ENVIRONMENTAL IMPACT ASSESSMENT (EIA) AND ENVIRONMENTAL MONITORING FOR AQUACULTURE

NOTE: Spaces can be expanded to fit your responses.

SECTION 0
BACKGROUND

1. Name:

2. Title:

3. Professional specialization:

4. Work area:

5. Country:

6. Institution you work for (ministry, research center, farm):

7. Electronic mail:

8. Fax:

9. Telephone:

10. Which are your country's three main aquaculture species?

11. How would you describe your role in the Environmental Impact Assessment (EIA) and Monitoring process? (indicate (x) for all that apply)

Role	EIA	Monitoring
Policy maker		
Regulator		
Scientist		
Researcher		
Industry representative		
Farmer		
NGO		
Other		
Comments:		
______________________________ ______________________________ ______________________________ ______		

SECTION 1
REQUIREMENTS

1. What are the requirements for Environmental Impact Assessments (EIA) in your country? What are the requirements to carry out farm monitoring?

2. What are the legal and regulatory requirements for?

   a. A proposal for a new farm development (new project)

   b. A change of practice in the established farms (i.e. expansion)

   c. Regular environmental monitoring (as carried out according to the particular legal regulations)

3. Information or direct sources for information on the matter in your country:

SECTION 2
VOLUNTARY AGREEMENTS

1. Which are the main methodologies used in the execution of Environmental Impact Assessments and Environmental Monitoring in your country?

2. Which are the law-based practices for carrying out the Environmental Impact Assessment and related environmental monitoring (i.e. practice codes, voluntary agreements, schematic certifications, etc.) in your country?

3. How is the Environmental Impact Assessment (EIA) carried out in the field?

4. In general, is there a requirement for the collection of data for the preparation of Environmental Statements? If so, which are the most common types of data that are required (e.g. benthic, side scan, nutrient concentrations, water currents, etc)?

5. Are initiatives for the application of models being used? If so, name examples.

6. If field sampling is required, are the sampling methods and equipment described in any procedure/norm? If not, are there any common standards?

7. Are there any norms or procedures for the degree of sample replication, identification of the number of stations and/or the length of the observation?

8. How is Quality Assurance addressed for field sampling and analysis? Is it established in any procedure?

9. Are there prescribed or standardized methods for data interpretation, analysis and presentation?

10. Have these methods been assessed for practicality and cost effectiveness?

11. Have Ecological Quality Standards been set for benthos or water columns?

12. Who is in charge of field measurements? (Farmers, consultants, regulators, researchers, NGOs, etc)

13. What are the most important constraints on monitoring practices? (Budget, expertise, bureaucracy, access to sites, etc)

SECTION 3
ASSESSING EFFECTIVENESS

1. Is there a general agreement on environmental protection between the industry, regulators and researchers, etc?

2. What is your opinion or personal evaluation regarding this?

3. Are there any feedback mechanisms for environmental monitoring, improved site selection, aquaculture performance and farm development? If there are, how do they work in practice, both at the individual farm level and regional or national level?

4. Are the prevention/mitigation/compensation measures recommended by the EIA process actually implemented? Do they reduce impacts on environmental quality? Please provide examples.

5. Have environmental quality objectives been set? Is there any effective environmental monitoring to assure they are met?

6. Is there an effective environmental monitoring that assures that these objectives are complied?

7. Are the legal requirements for EIAs, monitoring practices and procedures regularly reviewed? How frequently?

8. Do stakeholders have different perceptions of the effectiveness of the EIA process in comparison with the regulating organization’s perceptions? If you are a stakeholder, please describe your views and those of others.

SECTION 4
SUGGESTED IMPROVEMENTS

1. Can you identify any constraints related to technical, scientific, financial, social and legal issues involved in the EIA process?

2. Can you suggest improvements which may be applied to these areas?

3. Which are the main needs of capacity building, development of competition and cooperation between producers, organizations, EIA and monitoring experts, regulators, NGOs, certifiers, etc. in your country?

4. Which are the most important environmental effects of the culture of the three most important species in your country? Please rank these with a scale of 1, 2 or 3. (1 being the most important issues and 3 being the least important issues).

Generic problem	*Rank (comments)*
Benthic / sediment effects	
Nutrients / water column / pelagic	
Medicines, chemicals	
Escapes	
Sea lice /diseases	
Other (describe)	

5. Are the most serious impacts well avoided or minimized with current EIA implementation in your country? Can you suggest any improvement to the EIA system and to other regulatory processes?

6. Do you have any other comments related to the way in which the aquaculture industry is regulated in your country?

SECTION 5
ENVIRONMENT AND NATURAL RESOURCES

1. Have new species been introduced in your country in the last ten years for aquaculture purposes? If so, which ones?

2. Do you possess any information related to mangroves and aquaculture (i.e. establishment, reestablishment, rehabilitation and usage for aquaculture?) Please provide quantitative data is you have it at your disposition.

3. Is the change of species culture appreciated in your country? Please provide quantitative data is you have it at your disposition.

4. Who else should we send this questionnaire to?

If you have any other comment that may contribute to this questionnaire, we would be pleased to meet you.

Thank you very much for contributing to this study.

ANNEX 3

PERSONAL INTERVIEWS

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Emilio Ochoa
Ecuador

ANSWERED SURVEYS

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Review of environmental impact assessment and monitoring in salmon aquaculture

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ABSTRACT

This report compiles and reviews environmental impact assessment (EIA) and environmental monitoring procedures and practices in salmon cage aquaculture in Canada, Chile, Ireland, New Zealand, Norway, the United Kingdom and the United States of America.

The regulatory process for pre-development EIA in each of the 7 countries is described. For existing farms, environmental monitoring regulations and practices are described and differences of approach noted. Weaknesses are highlighted and some suggestions for improvement are given.

All the countries studied have a regulatory system in place for a systematic study of the environmental costs and benefits of a proposed new salmon farm (EIA). The EIA system highlights potentially negative environmental impacts but socio-economic costs and benefits are generally not part of the EIA process. However, in some countries, e.g. Scotland, a brief socio-economic analysis is often included. A more rigorous and explicit approach to assessing socio-economic costs and benefits would be very helpful in allowing decision-makers to balance these against any environmental costs.

All countries have regulations regarding the monitoring of existing salmon farms to ensure compliance with a variety of environmental standards. In most countries there is a perception that regulation does offer protection to the environment. However, in most cases farmers regard the regulatory process as relatively slow and bureaucratic. This is particularly the case in the United States of America where responders to a questionnaire indicated that development was stifled by the complex regulatory regime. In Chile, while regulations and standards exist, there is a perception that regulatory authorities have insufficient resources to adequately monitor performance and police compliance.

In all countries, but particularly in North America, greater dialogue between all stakeholders in a non-litigious arena would be highly beneficial, as there appears to be considerable mistrust between the industry, the regulators and NGOs. Interchange of scientists and regulators between salmon growing countries and the willingness to learn from regulatory developments in other countries, must be strongly supported. All countries need to put greater effort into determining impacts at the waterbody rather than site scale. This requires modelling approaches backed up by long time-series measurements for validation and calibration.

Improvements in technologies for preventing escapes and in regulation should follow the Norwegian example where escapes of farmed fish must be reported on a statutory basis, particularly in Atlantic areas. Sea lice are a threat to wild populations so compulsory delousing should be implemented in all jurisdictions (following Norway) and a robust framework of basin-scale cooperation between farmers and wild fish interests regarding synchronous stocking and treatment should be encouraged to minimize medicine use. There is a clear need for environmental data collected at farms to be placed in the public domain to increase confidence in the regulatory process.

CONTENTS

Acronyms and abbreviations

AAA	Authorised Area for Aquaculture (Chile)
ADRIS	Association of Directors and River Inspectors of Scotland
AEE	Assessment of Environmental Effects (New Zealand)
ALL	Aquatic Lands Lease (United States of America)
AM	Annual Monitoring (United States of America)
AMA	Aquaculture Management Area (New Zealand)
ANZECC	Australian and New Zealand Environmental Conservation Council
APL	Clean Production Agreement (Chile)
ASERC	Aquaculture site Environmental Review Committee (Canada)
AZE	Allowable Zone of Effects (United Kingdom)
BA	Biological Assessments (United States of America)
BC	British Columbia (Canada)
BCSFA	British Columbia Salmon Farmers Association (Canada)
BEP	Best Environmental Practice (United Kingdom)
BIM	Irish Sea Fisheries Board (Ireland)
BS	Baseline Monitoring
CAAP	Concentrated Aquatic Animal Production (United States of America)
CAR	Water Environment (Controlled Activities) (Scotland) regulations 2005
CBD	Convention on Biological Diversity
CEAA	Canadian Environmental Assessment Act (Canada)
CEQ	Council on Environmental Quality (United States of America)
CITES	Convention on the International Trade on Endangered Species
CLAMS	Co-ordinated Local Aquaculture Management System (Ireland)
CoGP	Code Of Good Practice (United Kingdom)
CONAMA	National Commission for the Environment (Chile)
CoPA	Control of Pollution Act (United Kingdom)
COREMA	Regional Commission for the Environment (Chile)
CPBA	Code of Environment Best Practice for Salmon Farms (Chile)
CPS	Preliminary Characterisation of Site (Chile)
CWA	Clean Water Act (United States of America)
DCMNR	Department of Communication, Marine and Natural Resources (Ireland)
DEP	Department of Environmental Protection (United States of America)
DFO	Department of Fisheries and Oceans (Canada)
DIA	Environmental Impact Declaration (Chile)
DMR	Department of Marine Resources (United States of America)
DENV	Department of the Environment (Canada)
EA	environmental assessment (Canada)
EC	European Commission
EC	Environmental Condition (Norway)
ECLAC	Economic Commission for Latin America and the Caribbean, (Chile)
ECOPACT	Environmental Code of Practice for Irish Aquaculture Companies and Traders (Ireland)
EEM	Environmental Effects Management (Canada)
EI	Environmental Information (Chile)
EIA	environmental impact assessment

EIS	Environmental Impact Statement (United States of America)
ELG	Effluent Elimination Guidelines (United States of America)
EMP	Environmental Management Program for the Marine Finfish Cage Aquaculture Industry in New Brunswick (Canada)
EPA	Environmental Protection Agency (United States of America)
EQS	Environmental Quality Standard
ES	Environmental Statement, resulting from an EIA
ESA	Endangered Species Act (United States of America)
ESPOO	United Nations Economic Commission for Europe: Convention on Environmental Impact Assessment in a Transboundary Context
FAO	Food and Agriculture Organization of the United Nations
FAWCR	Finfish Aquaculture Waste Control Regulation (Canada)
FLE	Framework Law on the Environment (Chile)
FONSI	Finding of no significant impact
FRS	Fisheries Research Services (United Kingdom)
GPS	Global Positioning System
HAB	Harmful Algal Bloom
HAS	Habitats of special significance
HPA	Hydraulic Project Approval (United States of America)
ICZM	Integrated Coastal Zone Management
ID	Identification
IMR	Institute of Marine Research (Norway)
INTESAL	Salmon Technological Institute (Chile)
ISO14001	International Organization for Standardisation standard primarily concerned with environmental management systems
ISO14004	International Organization for Standardisation standard primarily concerned with environmental management systems
ISO9001	International Organization for Standardisation standard primarily concerned with quality management systems
LA	Local Authority
MAL	Ministry of Agriculture and Land (Canada)
MARPOL	International Convention for the Prevention of Pollution from Ships, 1973, as modified by the Protocol of 1978 relating thereto
MDEP	Maine Department of Environmental Protection
MePDES	Maine Pollutant Discharge Elimination System (United States of America)
MEQO	Marine Environmental Quality Objectives (Canada)
MOE	Ministry of the Environment (Canada)
MOM	Modelling-On-growing fish farms-Monitoring
MSc	Master of Science Degree (United Kingdom)
MWLA	Ministry of Water, Land and Air (Canada)
N/A	Not Applicable
NBDAFA	New Brunswick Department of Agriculture, Fisheries and Aquaculture (Canada)
NBDELG	New Brunswick Department of the Environment and Local Government
NBDENV	New Brunswick Department of the Environment (Canada)
NCPA	Norwegian Pollution Control Authority
NEPA	National Environmental Policy Act (United States of America)
NGO	Non-Governmental Organization
NIVA	Norwegian Institute for Water Research
NOAA	National Oceanic and Atmospheric Administration (United States of America)

NPDES	National Pollutant Discharge Elimination System (United States of America)
NS9410	Norwegian Environmental Monitoring Standard
NS9423	Norwegian Environmental Monitoring Standard
NYTEK	Technical Requirements for Fish Farming Installations (Norway)
OECD	Organisation for Economic Co-operation and Development
OSPAR	Convention on the Protection of the Marine Environment of the North East Atlantic (United Kingdom)
PBS	Performance Based Standards (Canada)
PSD	Preliminary Site Description (Chile)
QA/QC	Quality Assurance/Quality Control
RAMA	Environmental Regulation for Aquaculture (Chile)
RAMSAR	The Ramsar Convention on Wetlands
RMA	Resource Management Act (New Zealand)
ROV	Remotely Operated Vehicle
RPD	Redox Potential Discontinuity depth
SAC	Special Area of Conservation
SAIC	Science Applications International Corporation (United States of America)
SALEIA	This case study on EIA and environmental monitoring in marine based salmon aquaculture in Canada, Chile, Ireland, New Zealand, Norway, the United Kingdom and the United States of America.
SBM	Single Bay Management (Ireland)
SCS	Site Characterisation Survey (United States of America)
SCUBA	Self Contained Underwater Breathing Apparatus
SEERAD	Scottish Executive Environment and Rural Affairs Department (United Kingdom)
SEIA	Environment Impact Assessment System (Chile)
SEPA	Scottish Environmental Protection Agency (United Kingdom)
SEPA	State Environmental Policy Act (United States of America)
SGS	Sediment Grain Size
SIGES	Integral Management System (Chile)
SMA	Shoreline Management Act (United States of America)
SNH	Scottish Natural Heritage (United Kingdom)
SOP	Standard Operating Practices for the Environmental Monitoring of the Marine Finfish Cage Aquaculture Industry in New Brunswick (Canada)
SPA	Special Protected Areas
SubPesca	Under Secretariat for Fisheries (Chile)
TOC	Total Organic Carbon
TBT	Tri-butyl Tin
UK	United Kingdom
UKAS	United Kingdom Accreditation Service
UNECE	United Nations Economic Commission for Europe
USA	United States of America
USACE	United States Army Corps of Engineers (United States of America)
USFWS	United States Fish and Wildlife Service (United States of America)
UWWT	Urban Waste Water Treatment EC Directive (United Kingdom)
VHS	Video recoding
WDFW	Washington Department of Fish and Wildlife (United States of America)
WDNR	Washington Department of Natural resources (United States of America)
WDOE	Washington Department of Ecology (United States of America)
WFGA	Washington Fish Growers Association (United States of America)

Introduction

APPROACH

The information presented in this report comes from a variety of sources including the peer-reviewed literature, the grey literature and the Internet – many important documents are now available only on the web. The amount and sources of information available varied between the study countries; the predominant sources of information for New Zealand were web based and very comprehensive, as was the United Kingdom of Great Britain and Northern Ireland. In the case of some countries, such as Canada and the United States some information was sourced from the Internet, but much of the detail was gained from questionnaire respondents. Throughout this report footnotes detail the specific information source and Web links. In addition, a questionnaire (Appendix 1) based on the terms of reference was circulated widely in each country to a range of stakeholder representatives, but the number of responses was disappointingly low (Appendix 2) – to those who responded we are extremely grateful. Information sourced from returned questionnaires is not directly referenced to individual responses to maintain anonymity.

INTERPRETATION OF EIA AND ENVIRONMENTAL MONITORING IN THIS REPORT

Formally, Environmental Impact Assessment (EIA) is the term used to describe the analysis of environmental costs and benefits that is required in many legislatures prior to granting a licence for some new development or extension of a pre-existing development that is perceived to have at least some negative environmental consequences. EIA is a short-term, one-off study used by coastal planners to inform sustainable development and coastal zone management. EIA assesses the likelihood of impacts and their significance and provides recommendations for mitigating the impacts.

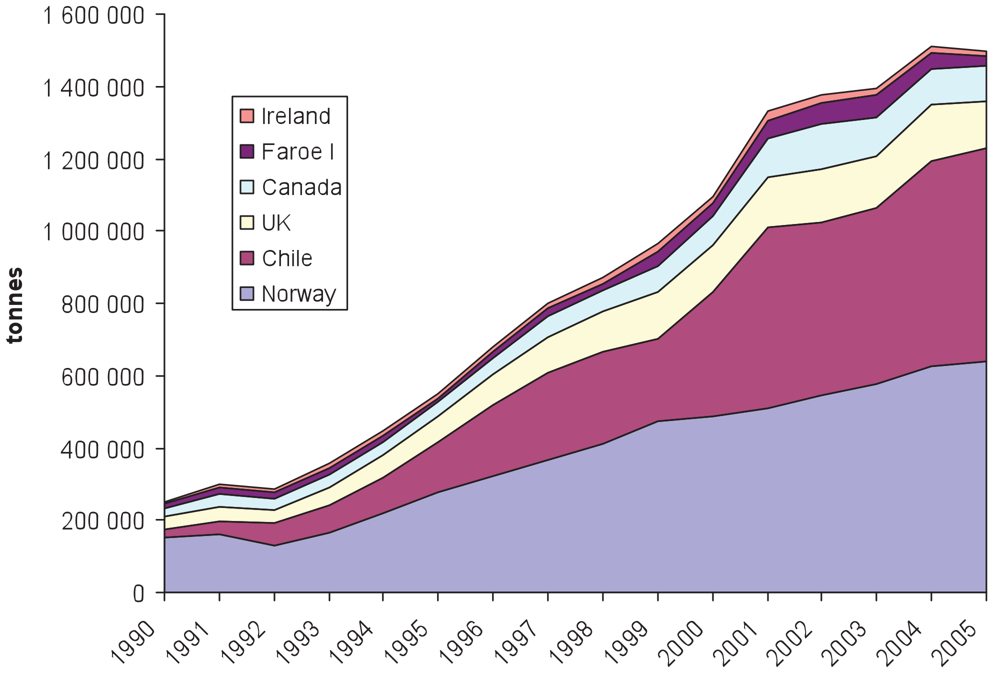
Quite separately, environmental monitoring of salmon farming is a process for determining the actual impacts of an operational farm. In all countries studied, environmental monitoring is established in law, occasionally supplemented by voluntary agreements. It may be carried out by independent bodies, governmental organizations or the farmer. In this report we have interpreted the terms of reference as referring to both practices and consider both in terms of informing the pre-development analysis and the post-development monitoring as required in each of the 7 different countries under study.

BACKGROUND

Globally the aquaculture industry is expanding rapidly, with the production of farmed salmon growing apace. With the continuing overexploitation of the worlds wild fisheries there will be increased pressure on industry to meet this shortfall and increase production. It is predicted that aquaculture production will exceed capture fisheries production by around 2030 (Brugère and Ridler, 2004).

The culture of salmonids is a significant industry in several mid-latitude countries and global production continues to increase at a fast rate reaching 1.3 million tonnes in 2005. Norway and Chile are the largest producers with 41 and 38 percent of total production respectively. The United Kingdom of Great Britain and Northern Ireland and Canada have only 8.5 percent and 6.4 percent, while the United States accounts for 0.6 percent and New Zealand 0.1 percent. (Figure.1)

FIGURE 1
Salmon farming annual production since 1990; countries comprising 97 percent of total world production



Source: FAO, 2007

As salmon culture expands there is growing awareness and intolerance of the negative environmental impacts that may result. Farming activities which may impact on the environment generally fall into two categories; those that have a detrimental effect on the ecosystem, the flora and fauna around the farm and those that impact on wild fish populations. These impacts are summarised in Table 1 below.

The level of impact varies according to production scale and farming techniques as well as the hydrodynamic, chemical and physical characteristics of the site and region and its environmental sensitivity; nutrient discharges will have less impact in a highly flushed site than in an enclosed fjord.

Salmon farming brings societal benefits to coastal areas where traditional employment opportunities are declining, by creating new jobs and businesses. Globally it provides opportunities to reduce the dependence on capture fisheries and to meet the demand

TABLE 1
Salmonid aquaculture activities and their environmental impacts

Farming activity	Source of impact	Potential environmental impact	Environmental risk
Discharge of particulate and dissolved nutrients	Waste feed Faecal matter Excretory products	Organic enrichment of sediments	Sediments underlying cages become anoxic and changes in benthic assemblage
		Nutrient enrichment of water column	Eutrophication
Discharge of chemicals	Medicines Anti-foulants	Eco-toxicity	Loss of sensitive species
Interactions with wild fish populations	Escapes	Genetic dilution of wild stock	Decrease in genetic diversity, fitness
	Disease and parasite transference	Diseased wild stock	Decrease in health, increase in mortality

Source: adapted from Scottish Executive, 2002.

for year round stable supplies of quality seafood (Fernandes *et al.*, 2000). However there are concerns relating to the sustainability of this industry. In 2002 the European Commission recognised the need to address this "through the integrated management of land, water and living resources promoting conservation and sustainable use of marine resources in an equitable way" European Commission, (2002[1]).

To ensure the industry is developing sustainably with minimal environmental impacts, the process of Environmental Impact Assessment (EIA) can be influential in determining which new sites, and extensions to production on existing sites, are approved. The subsequent environmental monitoring of operational sites will determine aquaculture industry management strategies. The objectives of environmental monitoring are that the farms activities do not adversely affect ecosystem function and productivity, do not lead to the deterioration of rare or sensitive habitats, take only a proportionate share of the resource with respect to other users and so are sustainable in the long term.

The EIA system was first formally established in the United States of America in 1969 and has since spread worldwide. Within Europe it has been subject to two European Commission Directives in 1985 and 1997, (85/337 and 97/11EC[2]). Subject to these Directives, salmon farming in marine waters comes under Article 4 (2) Annex II where the requirement for an EIA is determined on a case by case basis or by thresholds and criteria set by each Member State. With its origins in land planning laws, there are difficulties in applying the EIA process to the marine environment; often in planning regulatory systems there is no authority below the low water mark and therefore no clear framework to aid decision-making. In contrast, environmental monitoring is tailored for the specific impacts of actual farming activities. It is used by regulatory bodies and industry to ensure farming practices comply with licensing consent stipulations.

EIA is a systematic process that assesses the impact of a planned (or existing) development on the environment. It is an aid to decision-making, the formulation of development actions and an instrument for sustainable development, (Glasson *et al.*, 1999). It combines a pro-active approach to environmental management by industry and administrative authorities, with aquaculture developments being designed to reduce or eliminate adverse environmental impacts and meet environmental standards prior to granting development consent. The pre-development EIA process should be information driven, with decisions made on the basis of sound baseline data, culminating with the production of an Environmental Statement (ES) by the developer, the content of which should include a range of elements (e.g. Box 1) that approaches a holistic analysis.

In addition to domestic national legislation and polices directed at marine environmental regulation there are international and regional obligations:

- international conventions and agreements – The United Nations Convention on the Law of the Sea, MARPOL for the control of discharges form shipping, CITES, RAMSAR, CBD and OSPAR;
- Regional European Directives- EIA Directives, the Habitats and Birds Directives, the Water Framework Directive.

This report considers the EIA approach and environmental monitoring in relation to salmon farming, implemented by seven countries: Canada, Chile, Ireland, New Zealand, Norway, the United Kingdom of Great Britain and Northern Ireland, the United States of America.

1 www.govdocs.aquake.org/cgi/reprint/2004/1017/10170080.pdf
2 www.europa.eu/environment/eia/full-legal-text/9711.htm

BOX 1*

Contents of an Environmental Statement

1. A description of the project, including in particular:
   - a description of the physical characteristics of the whole project and the land-use requirements during the construction and operational phases;
   - a description of the main characteristics of the production processes, for instance, nature and quantity of the materials used;
   - an estimate, by type and quantity, of expected residues and emissions (water, air and soil pollution, noise, vibration, light, heat, radiation, etc.) resulting from the operation of the proposed project.
2. An outline of the main alternatives considered by the developer and an indication of the main reasons for this choice, taking into account the environmental effects.
3. A description of the aspects of the environment likely to be significantly affected by the proposed project, including, in particular, population, fauna, flora, soil, water, air, climatic factors, material assets, including the architectural and archaeological heritage, landscape and the inter-relationship between the above factors.
4. A description of the likely significant effects of the proposed project on the environment resulting from:
   - the existence of the project;
   - the use of natural resources;
   - the emission of pollutants, the creation of nuisances and the elimination of waste.

   and the description by the developer of the forecasting methods used to assess the effects on the environment.
5. A description of the measures envisaged to prevent, reduce and where possible offset any significant adverse effects on the environment.
6. A non-technical summary of the information provided under the above headings.
7. An indication of any difficulties (technical deficiencies or lack of know-how) encountered by the developer in compiling the required information.

From Annex IV, "Information referred to in article 5 (1) of the amended (1997) EIA Directive"

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* www.europa.eu/environment/eia/full-legal-text/9711.htm

The regulatory requirements and voluntary practices for EIA and environmental monitoring of salmon farms

In this section we briefly summarise the key features of the EIA process for salmon marine cage aquaculture in each of the 7 countries chosen. Where possible, references are given to original source regulations or other documentation but these are not reproduced in detail here.

CANADA

Aquaculture operations in Canada are regulated both at federal and provincial level. The Department of Fisheries and Oceans (DFO) is the lead federal department responsible for the management of aquaculture[3]. It is the DFO's responsibility to review aquaculture license applications in order to identify and help mitigate any impacts on marine environmental and wild fish stocks. The main federal legislative tool guiding the environmental assessment process within Canada is the Canadian Environmental Assessment Act (CEAA). The act came into force in 1995. The act details the responsibilities of the federal government in relation to the environmental assessment of projects, including aquaculture projects. Approval for aquaculture projects can only be given once an environmental assessment has been carried out under the CEAA. The assessment is carried out to ascertain the potential impacts of the proposed aquaculture operation. The Canadian Environmental Assessment Agency[4] was established under the CEAA in order to administer and promote the federal environmental assessment process. Both Environment Canada and DFO have responsibilities under the Fisheries Act. Environment Canada is responsible for promoting pollution prevention and sustainable management practices, as well as ensuring that water quality is maintained, while the DFO, through the Act, prohibits the harmful alteration, disruption or destruction of fish habitat. Both agencies also have responsibilities under the Species at Risk act in order to ensure that species at risk are not harmed or killed as a result of aquaculture activities.

All proposed aquaculture facilities are also reviewed and require approval under both the Navigable Waters Protection Act[5] (through Transport Canada department) and the Fisheries Act to assess any impacts on wild fish stocks and fish habitats.

During the Environmental Assessment (EA) the DFO or provincial governments may consult with other federal or provincial departments and agencies as is deemed necessary (such as Environment Canada, the Department of Indian Affairs and Northern Development, Integrated Land Management Bureau).

There are four types of EA carried out under CEAA:

- screening (including class screening)
- comprehensive study
- mediation
- review panel

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[3] www.dfo-mpo.gc.ca/aquaculture
[4] www.ceaa-acee.gc.ca/index_e.htm
[5] www.dfo-mpo.gc.ca/aquaculture).

The majority of marine aquaculture projects will undergo a 'screening' EA. This type of EA is aimed at detailing the environmental effects of an aquaculture project. As a result of the EA there may be a recommendation to minimize or mitigate such impacts or modify the aquaculture project proposed. The outcome of the EA may also recommend further assessment, either through mediation or the review panel process[6].

Under the Fisheries and the Species at Risk Acts, substantial consideration is given to ensuring that fish habitats and any species at risk are not threatened by aquaculture activities or impacts. Atlantic salmon escapes can have significant ecological consequences on the west coast of Canada, where this species is not indigenous. In British Columbia there are substantial regulations covering the prevention of escapes.

Provincial government is responsible for issuing operating licenses, ensuring compliance with regulations (both provincial and federal) and carrying out onsite inspections. In British Columbia (BC) the Ministry of Agriculture and Land (MAL) is responsible for assessing aquaculture applications and issues licenses under the provincial Fisheries Act. Together with the Ministry for the Environment, MAL are responsible for the compliance and enforcement of aquaculture regulations in BC. The impact of fish waste products is regulated through environmental standards set by the Ministry of Water, Land and Air protection. The Finfish Aquaculture Waste Control Regulation, or FAWCR, (BC regulation 321/2004[7]) is part of the Environmental Management Act (BC) and provides the legal authorization for finfish farms to discharge waste. This regulation requires farmers to monitor the marine environment to determine any detrimental effects on the benthic environment. This regulation is administered through the Environmental Protection Division of the Ministry of Environment.

In New Brunswick, the Department of Agriculture, Fisheries and Aquaculture (NBDAFA) is responsible for reviewing and approving marine aquaculture sites and for the control of the spread of disease, parasites, toxins and other contaminants. The New Brunswick Department of the Environment (NBDENV), under the Clean Environment Act, are responsible for administering an Approval to Operate certificate, which sets out the conditions with which the site must comply. This includes environmental monitoring requirements and waste managements plans. An Environmental Management Program for the Marine Finfish Cage Aquaculture Industry in New Brunswick (EMP) was developed by NBDENV in 2006 and is enforced through the Aquaculture Approvals programme under the Water Quality Regulation (part of Clean Environment Act) and the Fish Habitat Protection provisions of the Fisheries Act (NBDENV 2006a). The EMP provides guidance on long-term environmental sustainability within the industry. The programme has several components, including the Environmental Management Framework and a Mitigation and Remediation programme. The EMP also details a set of Operational Best Management Practices to be used by the finfish industry. These practices have been devised to minimise the organic and inorganic loading from finfish aquaculture activities. Guidance is provided on a number of issues, including waste management, equipment cleaning and disinfection, feed handling and storage and feeding practices.

Voluntary systems

The British Columbia Salmon Farmers Association (BCSFA) Code of Practice[8] was revised in 2005. The code is aimed at improving sustainable environmental stewardship and maximising product quality assurance. The code has five principles, including a commitment to minimise impacts on the environment and to ensure a healthy environment for culturing salmon stock. A number of industry companies in British

[6] www.dfo-mpo.gc.ca/aquaculture/ref/AAPceaafin_e.pdf
[7] www.al.gov.bc.ca/fisheries
[8] www.salmonfarmers.org/attachments/codeofpractice1.pdf

Columbia are also involved in application of ISO 14004 Environmental Management Systems[9].

The New Brunswick Salmon Growers Association devised an Environmental Policy and Code of Practice[10] in 2004. This policy provides a commitment to sustainable development and operation of the salmon industry as well as setting out a number of guiding principles that can be applied to all aspects of the industry.

CHILE

The General Fisheries and Aquaculture Law (Law 18.892, 1989) is the primary legislative tool applied to the establishment and authorization of aquaculture facilities in Chile[11] (Leon, 2006). The Ministry of Economy, Promotion and Reconstruction has jurisdiction over the prevention of the introduction and spread of high risk diseases and ensures that aquaculture development is in accordance with the carrying capacity for the area. This law defines concessions and authorizations depending on where the project site is – coastal area, beach, water column and sea bed lots. A number of regulations apply to the planning and authorization of aquaculture facilities, these were summarised by Leon (2006) as follows:

- Regulation for Aquaculture Concessions and Permits (SD 290/93);
- Regulation of the Environmental Impact Assessment System (SD 95/2001);
- Environmental Regulation for Aquaculture, RAMA (SD 320/01);
- Regulation for Protective, Control and Eradication Measures of High Risk Diseases of Hydrobiologic Species (SD 319/2001);
- Regulation for the Control of Water Pollution (SD 1/1992);
- Navigation Law (SD 2222/1978).

SubPesca (Under Secretariat for Fisheries) has the authority to grant aquaculture concessions and authorizations, while SerNaPesca (National Service for Fisheries) is responsible for maintaining a national register of aquaculture facilities. The Ministry of National Defence has the responsibility for granting concessions on State owned property. Potential operators must submit an application for the proposed aquaculture project to SerNaPesca, who are charged with verifying the information and ensuring that all requirements under Regulation for Aquaculture Concessions and Permits have been met. The application and associated reports are then submitted to SubPesca, who certify that all permit requirements have been met. The applicant may then submit the project to the Environmental Impact Assessment System.

In collaboration with SubPesca, the Ministry of National Defence is responsible for establishing areas which are suitable for aquaculture development. To date, two areas have been decreed as Authorised Areas for the establishment of Aquaculture (AAA, Law 18.892), <Norte Chico> and <Sur> (Leon 2006). These areas are deemed to be suitable for aquaculture and there is seen to be reduced conflict with other potential resource uses such as small-scale community fisheries, protected areas (parks and reserves), important navigational areas and natural shellfish beds.

The Framework Law on the Environment (FLE), No. 19.300 (1994) states that aquaculture activities are subject to an EIA process. The main coordinating agency for FLE is CONAMA (National Commission for the Environment). This body represents 13 State ministerial departments and is represented at the regional level by COREMA (Regional Commission for the Environment). CONAMA is responsible for coordinating governmental environmental policies and preparing appropriate environmental regulations (OECD, 2005). Project applications must be registered with either CONAMA or COREMA, depending on whether the environmental impact pertains to one or more regions. The General Law on Fishing and Aquaculture and the

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[9] www.iso14000-iso14001-environmental-management.com/index.htm

[10] www.nbsga.com/articles/2004-CodesandPolicyJune2004CompleteDocument(1).pdf

[11] www.fao.org/fi/website/FIRetrieveAction.do?dom=legalframework&xml=nalo_chile.xml

Regulations for Aquaculture Concessions and Permits provides the legal framework for the granting of aquaculture permits and concessions and sets out the environmental requirements.

Aquaculture activities on private and State owned land are subject to the EIA process and environmental permits are granted though that process. The Environmental Regulation on Aquaculture[12], RAMA (SD 320/2001), was introduced in 2001 to provide regulatory authority for assessing environmental impacts and associated mitigation measures within the aquaculture industry (Leon, 2006). The focus of this regulation is placed on avoiding and assessing sediment anoxia (Niklitschek *et al.*, 2005). This regulation requires the mandatory preparation of the Preliminary Characterisation of Site, or PSD (OECD, 2005), for all water column and sea bed lot projects, which must be submitted to SubPesca. The aim of the study is to provide information on the biological, physical and chemical parameters of the proposed project site. The Regulation on the EIA System (SEIA, 1997) provides the regulatory framework to aquaculture operations through the sectoral environmental permits. An aquaculture facility may be required to submit an Environmental Impact Declaration (DIA). However, where a project is deemed to have the potential for additional major impacts, (Box 2), an Environmental Impact Study (EIA) may be required.

The EIA is aimed at providing adequate field information to identify and predict potential impacts and enable formation of any mitigation measures. The DIA are used for projects where there is less potential impact on the environment. The public have the opportunity to be involved in an EIA, but this is not necessary for a DIA. CONAMA and COREMA publish a list of all Declarations and Studies presented, on a monthly basis. All relevant agencies involved in the EIA process must approve the final technical report, which is compiled by the Commission. The technical report contains a number of items, including but not limited to:

- reference to the technical reports drafted by the other participating agencies;
- summary of the observations made by the community;
- summary of the environmental impact assessment, of the main environmental impacts and of the proposed mitigation, repair and compensation measures;
- conclusions on the appropriateness of the proposed mitigation, repair and compensation measures with regard to the effects for which an Environmental Impact Study is required;
- indication of the sectoral environmental permits, related to the project or activity.

BOX 2

Additional factors requiring a full Environmental Impact Study for an aquaculture project in Chile

- risk to human health, caused by the quantity of effluents or waste matter;
- significant adverse effects on renewable natural resources, including soil, water and air;
- resettlement of human communities, or significant alteration of the life system and customs of local communities;
- location close to human communities, protected areas or resources which may be affected;
- significant alteration, to the scenic or tourism value of an area;
- alteration of monuments, sites of anthropological, archaeological or historical interest and areas of cultural significance.

12 www.subpesca.cl/docs_ingles/RAMA_english.pdf

Voluntary systems

Several codes of practice and industry agreements have been drawn up by the salmon farm industry in support of improving environmental quality of culture sites. SalmonChile (previously Chilean Salmon and Trout Producers Association) has developed a number of these agreements, including:

- Clean Production Agreement (APL)
- Sustainable Production Agreement
- Integral Management System (SIGES)

Fundación Chile has developed the Code of Environmental Best Practices for salmon farms (CPBA) (Niklitschek *et al*., 2005; OECD, 2005; Leon, 2006). In 1995, SalmonChile set up a technical branch, Salmon Technological Institute (INTESAL). This organization has been concerned with a number of technological issues within the salmon industry, including research and promotion of technologies aimed at improved efficiency and reducing environmental impact (Niklitschek *et al.*, 2005). Exporting companies in Chile are reported to be progressing toward the implementation of environmental and quality standards, such as ISO 14001 and ISO 9001.

IRELAND

Under the Irish regulations for implementing the EC Directives 85/33/EEC and 97/11/EC in relation to EIA, for some salmon farm activities an EIA is mandatory, for others it is at the discretion of the Minister of the Marine, Head of the Department of Communications, Marine and Natural Resources, the principal regulatory authority for the industry. According to the EC Directive, "intensive fish farming" falls under Annex II Class 1 (f), which means that each member State may accord specific criteria for the application of EIA on a case by case basis.

Ireland has approached EIA requirements for aquaculture activities by applying different requirements to fish breeding installations than to fish rearing installations. An EIA is mandatory for all marine salmonid breeding installations for which a licence is sought, as opposed to a salmon farm were an EIA may be requested by the Minister for the Marine if the salmon farm is deemed likely to have a significant effect on the environment.

Similar to Norway, Irish EIA is closely associated with planning laws. The first legislative instruments addressing EIA were implemented in 1989, when statutory procedures were laid down and the content of an ES were specified. The requirements for EIA of salmon farming installations were reviewed in 1999, resulting in a more rigorous approach. The current system requires that a marine salmon development applies for two licences; a foreshore licence issued under a planning law, the Foreshore Act 1933 and an aquaculture licence issued under the Fisheries Amendment Act (1997). This means that an EIA may be requested by local authorities under the former legal instrument, as well as the Minister for the Marine under the latter[13]. Where an EIA is required the farmer can only apply for the foreshore and aquaculture licences once approval has been gained.

The foreshore licence specifies the dimensions and number of fish cages allowed at each site and is generally issued for ten years. The aquaculture licence clearly defines the type of aquaculture allowed at the site for a specified period of time, which will not exceed 20 years, the norm being ten years. These two licenses are linked in that the granting of one is contingent on the other. A 'trial licence' may also be applied for under the Fisheries Amendment Act (1997). This licence permits aquaculture activities that have an investigative or experimental nature and will not be for more than one year. Trial licences are not renewable.

[13] dcmnr.gov.ie/Marine/Environmental+Assessment/Environmental+Assessment.htm

BOX 3
Irish Aquaculture Licence Conditions

- Only salmon may be cultivated under the terms of the licence.
- The position of the cages shall not prevent the passage of migratory fish and all necessary precautions will be taken to prevent the escape of farmed fish.
- Records shall be kept of all chemicals and antibiotics discharged, quantity and date of use.
- Any disease, abnormal loss or mortality of fish will be notified to the Department of the Marine and Natural Resources within 24 hours.
- The Department of the Marine and Natural Resources shall be notified within 24 hours of any escapes of farmed fish.
- Prior approval must be sought from the Department of the Marine and Natural Resources for any cages towed into or away from the licensed area.

Aquaculture Licence Special Conditions (assigned on a case by case basis):
- annual production levels;
- annual smolt input;
- maximum stocking density – 15 kgm^{-3} and not to exceed 20 kgm^{-3} at any one time;
- a minimum fallowing period, typically 60 continuous days;
 environmental monitoring.

McMahon, 2000.

The aquaculture licence has several general and special conditions attached, relating to escapes, fish disease, stocking density and environmental monitoring (Box 3).

The environmental monitoring requirements stipulated in the licence include:
- sea lice monitoring
- water column monitoring
- sea bed monitoring

Voluntary systems

Voluntary initiatives have been established since 1992. The first management initiative was a Single Bay Management Plan (SBM), which set out agreed husbandry practices. The SBM has recently been developed further into Co-ordinated Local Aquaculture Management System[14] (CLAMS). This is overseen by the Irish Sea Fisheries Board and includes all resource users in developing and implementing a locally relevant management system that can evolve with changing needs.

In conjunction with the CLAMS process an initiative for environmental management has been developed by the Irish Seas Fisheries Board and the Irish aquaculture industry; the Environmental Code of Practice for Irish Aquaculture Companies and Traders[15], (ECOPACT). ECOPACT is designed to encourage widespread adoption of environmental management systems by the industry.

NEW ZEALAND

In New Zealand EIA (or as it is referred to there, ‘Assessment of Environmental Effects’, (AEE)), is integrated into the statutory planning framework of the Resource Management Act (RMA, 1991). Prior to this there was no statute relating to EIA, but with the implementation of the RMA all resource consents require an EIA/AEE, irrespective of the size of the development. The content of an EIA/AEE has been outlined[16].

[14] www.bim.ie/templates/text_content.asp?node_id=244
[15] www.bim.ie/templates/text_content.asp?node_id=700
[16] www.es.govt.nz/Departments/Consents/assessment%20of%20effects.aspx.

The aquaculture industry has come under the jurisdiction of the RMA with the Aquaculture Reform Act[17] (2004), which took effect on 1 January 2005. This act has simplified the legislative process in relation to managing the aquaculture industry, replacing the two-permit system with a single consent application, a coastal permit and restricting salmon farms to designated Aquaculture Management Areas (AMAs). The coastal permit sets the limits of the scale of the salmon farm, productivity and location. Inherent in the coastal permit is the assessment of environmental effects, which feeds directly into the environmental monitoring requirements of each AMA. The responsibility of administering coastal permits for salmon farms lies with the regional councils, who also monitor the environmental impacts of the farm.

Each regional council in New Zealand has produced a Regional Coastal Plan and this stipulates whether there is an AMA in that region and, if so, the conditions that the salmon farm must conform to, dependent on the sensitivities of the receiving environment. The coastal plan determines whether the salmon farm needs 'resource consents' to operate. Resource consents allow the salmon farmer to discharge pollutants into the waterbody. If the coastal plan does not require this of the farmer, a certificate of compliance must be issued to the farm to allow it to operate lawfully.

Currently there are three areas in New Zealand where salmon farms operate, each coming under the jurisdiction of a different Regional Council (Southland, Canterbury and Marlborough). Each regional council has a different environmental monitoring strategy, but in all areas the onus is on the farmer to avoid, mitigate or remedy any adverse environmental effects. The areas highlighted in the Southland Regional Coastal Plan[18] where salmon farming can create adverse effects are listed in Box 4.

Incorporated into each AMA is a refuge area which the farm can utilize if an event should occur requiring the temporary relocation of the farm to maintain the health of the farmed stock, e.g. harmful algal bloom (HAB). The coastal plan also regulates on the effects that may occur when the farm has to move and includes the transmission of exotic species. It is considered that the physical difficulties and restrictions applied to farms whilst occupying a refuge site are incentive enough to ensure a return to the original location as soon as it is appropriate without additional regulations needed.

BOX 4

Regional Coastal Plan for Southland, recognized areas of adverse effect of salmon farming

Each farm in an AMA will be monitored to assess environmental effects and effects on other coastal resource users. The areas recognised where salmon farming can have adverse effects are:

- exclusive occupation of large areas;
- interference with navigation;
- reduced amenity value;
- visual impacts;
- build up of benthic sediments;
- discharge of contaminants;
- interference with heritage values;
- water quality impacts;
- loss of natural character;
- loss of habitats of significant indigenous fauna and significant indigenous vegetation.

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17 www.mfe.govt.nz/rma/index.php

18 www.es.govt.nz/Departments/Planning/index.aspx#CoastalPlan

Voluntary Codes of Practice

New Zealand is currently developing a National Environmental Code of Practice[19], encompassing all aspects of aquaculture. This will replace the current practice where farms develop a voluntary code in association with other stakeholders.

NORWAY

Norwegian salmon farming is strictly controlled by a number of laws and regulations[20]. The Ministry of Fisheries and Coastal Affairs is the principal regulatory authority responsible for the industry, with three other Ministries also having a degree of authority; the Ministry of Environment, the Ministry of Agriculture (disease control and regulations) and the Ministry of Local Government and Labour. The Aquaculture and Coastal Management Department of the Directorate of Fisheries has overall responsibility for management of the Aquaculture Act[21]. In relation to EIA the responsibility for Norwegian environmental policy lies with the Ministry of the Environment, with this Ministry developing legislation and guidelines. In relation to EIA of salmon farms, the Directorate of Fisheries is the competent authority but the Norwegian Pollution Control Authority (NCPA) - a Directorate under the Ministry of the Environment – and the County Governor's Department of Environmental Affairs have particular responsibilities.

The Norwegian Government adopted the first generation of legislation on EIA in 1990, as part of the Planning and Building Act and the EIA system continues to be closely integrated with land use planning processes. In 1999 the management of the EIA system was revised and responsibility was devolved to local authorities. The current EIA provisions implement the EC Directive 97/11/EC on EIA and the requirements of the UN ECE Convention on Environmental Impact Assessment in a Transboundary Context, (the Espoo Convention)[22].

An EIA may be required for a movable/floating marine salmon farm with a volume of 48 000 m^3 or more, or a permanent marine farm site with a volume of 36 000 m^3 or more, according to criteria listed in Section IV of the Norwegian Regulations[23]. If the competent authority decides that an EIA is required no permit will be granted until the requirements have been fully satisfied. Once approved the Directorate of Fisheries may order additional monitoring, to that already required under statutory monitoring, before the farm begins operating, during operation and after the site is abandoned.

The regulatory framework was established in 1973, through the Act of Fish Farming, revised in 1981, 1985 and 2006. All regulations applicable to salmon farming are transposed into a common regulation (The Operation and Diseases Regulations ([2004]). These regulations are implemented through a licensing system, issued by the Ministry of Fisheries and Coastal Affairs and through a monitoring programme drawn up by the Pollution Control Authorities. The licensing system sets limits on the size of fish farms and the numbers of licences issued and requires the licensee to provide a comprehensive annual report detailing the operational activities of the farm. The licence requires the farmer to keep records regarding the operational activities of the farm.

In 1997 Norway implemented the National Action Plan for sea lice on salmon farms, ratified by law and enforced by the Norwegian health authorities. This gives local authorities the jurisdiction to gather monthly reports, make unannounced checks on farms and demand delousing if lice levels exceed the targets in the plan (Boxaspen, 2006).

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19 www.nzmic.co.nz/Assets/Content/Publications/sector%20strategy%20final%20low%20resolution.pdf
20 lovdata.no/info/lawdata.html
21 www.fiskeridir.o/fiskeridir/english/about_the_directorate/about_the_departments_1/the_aquaculture_and_coastal_management_department)
22 www.unece.org/env/eia
23 www.regjeringen.no/nb/dokumentarkiv/Regjeringen-Bondevik-I/231606/232935/260617/t-1306_environmental_impact_assessment.html?id=260622

BOX 5

Norwegian Standard – NS9415 – design, dimensions construction installation and operational requirements.

This standard contains requirements for the physical design of the installation and the associated documentation. This includes calculation and design rules, as well as installation, operating and maintenance requirements.

There are requirements for the physical design of all the main components in an installation, functionality after assembly and how the installation shall be operated to prevent escape.

All components of new installations must be certified by an accredited body and existing installations must be issued with a capability certificate.

The standard stipulates what parameters shall be used to determine the natural conditions at a given locality and the procedure for classification of localities.

In addition to regulating the operational activities of the farms, Norway adopted a new regulation in 2003, implemented from January 2006, with a certification scheme, which sets an industry standard for cage construction and mooring systems (NS9415, see Box 5). Referred to as the Nytek regulations[24], all new farms must hold a certificate for each site.

The monitoring programme is based on an environmental management system called Modelling-Ongrowing fish farms-Monitoring (MOM). It integrates elements of EIA, monitoring of impacts and achieving Environmental Quality Standards (EQS) into one system (Ervik *et al.*, 1997; Maroni, 2000; Hansen *et al.*, 2001). There are two monitoring investigations (B and C) of increasing complexity and monitoring frequency depending on the degree of environmental impact and three zones to which impact assessment criteria are applied, (local, intermediate and regional). Monitoring investigation B is applied to the local zone and monitoring investigation C is applied to the intermediate and regional zones (Hansen *et al.*, 2001). The frequency of applying the B investigation is directly related to the degree of exploitation of the site, whereas the frequency of employing C investigation is at the discretion of the local authority. EQS's are set for the parameters of both investigations and the monitoring is described in Norwegian Standard NS9410.

Currently Norway is reviewing the regulation and monitoring procedures in relation to aquaculture, primarily in response to escapes. Included in this review is the recommendation that a separate environmental monitoring program is implemented, as part of an environmental action plan developed by the Ministry of Fisheries and Coastal Affairs[25].

Voluntary systems

There are no voluntary self monitoring systems or codes of practice in Norway.

UNITED KINGDOM

The Aquaculture industry in the United Kingdom is primarily located in Scotland, along the West coast and in Orkney and Shetland. Scotland produces 90 percent of the United Kingdom finfish market, 95 percent of which is Atlantic salmon; therefore, this report focuses on the regulation and monitoring framework in Scotland.

In the United Kingdom of Great Britain and Northern Ireland, EC Directive 85/337 (the EIA Directive) is implemented through over 40 different secondary regulations, in response to this Scotland (which has a separate legal system from the rest of the

[24] www.tekmar.no/tema/ns9415.asp

[25] www.fiskeridir.no/fiskerdir/english/news/vision_no_escapees

United Kingdom of Great Britain and Northern Ireland) developed three Statutory Instruments (secondary legislation):

- Part 2 of the Environmental Assessment (Scotland) Regulations 1988 (Statutory Instrument (SI) 1221);
- Town and Country Planning (General Development Procedure) (Scotland) Order 1992 (SI 224);
- Environment Assessment (Scotland) Amendment Regulations 1994 (SI 20212).

In respect to salmon farming, the regulations were reviewed in 1999 pending the transfer of responsibility for authorization of marine aquaculture from the Crown Estate to local authorities in 2006. This review resulted in the implementation of the main legislative act now applying to marine fish farming:

- Statutory Instrument no 367: The Environmental Impact Assessment (Fish Farming in Marine Waters) Regulations 1999

The main actors with responsibility for regulating salmon farming in Scotland are outlined in Box 6.

The 1999 regulations specify criteria that determine whether a proposed new aquaculture development or modification to an existing development requires an EIA. These are:

- all proposals in 'sensitive areas' as defined in the Regulations;
- all new proposals with a designed biomass ≥100 tonnes or cage surface area ≥1 000m^2;
- any modifications with a designed biomass ≥100 tonnes or cage surface area ≥ 1 000m^2.

The new legislation[26] (Environmental Assessment (Scotland) 2005 Act), regarding EIA came into force in Scotland in February 2006. This Act transfers authority to Scottish local authorities who now have the responsibility for formally determining whether an EIA is required which previously rested with the Crown Estate. In the Scottish Islands of Shetland and Orkney, local councils have had that authority since 1974, under the County Council Act (1974).

BOX 6

Key Regulatory Bodies of Scottish Aquaculture

The Crown Estate – the owner of the sea bed and currently regulates the aquaculture industry through the issuing of sea bed leases. EIA is a requirement of the lease under Environmental Impact Assessment (Fish farming in marine waters) Regulations 1999.

Scottish Environmental Protection Agency (SEPA) – a government agency responsible for safeguarding the cleanliness of Scotland's tidal waters and protecting aquatic fauna and flora. SEPA regulates the aquaculture industry through the issuing of discharge consents under the Water Environment (Controlled Activities) (Scotland) Regulations (2005).

Scottish Natural Heritage (SNH) – responsible for conserving the Scottish environment and it is consulted on the environmental impacts of aquaculture by the Crown Estate on EIA and SEPA on discharge consents.

Local Authorities – advises Crown Estate on lease conditions – shortly to replace the Crown Estate as the statutory planning authority for aquaculture.

Scottish Government Environment and Rural Affairs Department (SEERAD) – has responsibility for the protection of fish, fisheries and the wider marine environment. All fish farms must register with it for the control of fish diseases.

[26] www.opsi.gov.uk/legislation/scotland/acts2005/20050015.htm

A review of current practice and decision-making process that applies to salmon farming is currently underway[27].

All proposed developments must apply for a lease to develop operations on the sea bed to the Crown Estate, apply the Local Authority (LA) for Planning Permission and to SEPA for 'Consent to Discharge'. The LA are responsible for screening, scoping and evaluating formal EIA, taking advice from a wide range of statutory and non-statutory bodies, and SEPA regulate and monitor the benthic and water column environmental impacts of the farms activities.

The SEPA 'Consent to Discharge' sets conditions and restrictions on the salmon farm to achieve a balance between site productivity and environmental impact. The main legislative instrument, the Control of Pollution Act (1974), upon which 'Consents' were set, was replaced by the Water Environment (Controlled Activities) (Scotland) Regulations 2005 on 1 April 2006. These regulations, referred to as the 'CAR' regulations, contain a pre-application discussion process between the farmer and SEPA that establishes the information that will be required to be included in an Environmental Statement (ES)[28]. 'Consent' conditions are drawn up on a site-by-site basis and include cage position and quantity, species farmed and biomass limits based on the carrying capacity of the receiving environment. 'Consent to discharge' are time limited and usually remain in place for a minimum of four years.

The main legislative instrument relating to salmon farming has been reviewed and this has led to the Aquaculture and Fisheries (Scotland) Bill (2006) being approved. On its implementation this Bill will make sea lice management and monitoring a statutory process and address the environmental impact of escaped fish[29].

There is no formal zoning system for fish farming in Scotland but the government has produced Locational Guidelines[30] that delineate coastal areas[31] according to their suitability for development on the basis of nutrient modelling and sensitive habitat assessment:

- Category 1 where the development of new or the expansion of existing marine fish farms will only be acceptable in exceptional circumstances. These are only likely to arise where it can be demonstrated conclusively, by the applicant, that the development will not have a significant adverse effect on the environmental qualities of the area.
- Category 2 where the prospects for further substantial developments are likely to be limited although there may be potential for modifications of existing operations or limited expansion of existing sites, particularly where proposals will result in an overall reduction in environmental effect, so enhancing the qualities of the area and hydrological conditions.
- Category 3 where there appear to be better prospects of satisfying environmental requirements, although the detailed circumstances will always need to be examined carefully.

Voluntary systems

The recently published Code of Good Practice for Scottish Aquaculture[32] is the main self-regulatory instrument and contains monitoring practices for sea lice control and environmental monitoring policies. The large majority of farms in Scotland are signatories to this code, which includes annual, independently accredited audits.

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27 www.sarf.org.uk/SARF024.htm
28 www.sepa.org.uk/pdf/wfd/regimes/car_practical_guide.pdf.
29 www.scottish.parliament.uk/business/bills/67aquaFish/index.htm
30 www.govdocs.aquake.org/cgi/reprint/2004/524/5240210.pdf
31 www.marlab.ac.uk/Delivery/Information_Resources/information_resources_view_document.aspx?contentid=1416
32 www.scottishsalmon.co.uk/aboutus/codes.asp

UNITED STATES OF AMERICA

The National Environmental Policy Act (NEPA, 1969) was the first legislative instrument to require an EIA/EIS process (in the United States of America an Environmental Impact Assessment is referred to as an EIS – Environmental Impact Statement). It operates at a federal level and is the basic national charter for protecting the environment, establishing policy and goals and provides a means for implementing policy[33]. The Council on Environmental Quality (CEQ) was created with the specific remit to interpret the Act and prepare guidelines on requirements for EIS. In 1977 the CEQ was given enforceable regulatory status in regard to NEPA and EIA/EIS. A "Lead Agency" is designated to co-ordinate the EIS process for any proposal or development. The "Lead Agency" is usually the local government and has the responsibility to make a "Determination of Significance". This process determines whether a full EIS is required or not, or whether a "finding of no significant impact" (FONSI) is required by a development. In relation to salmon farming a permit system regulates the industry. All new salmon farm developments are subject to the EIS system. The whole system is governed and referred to as the State Environmental Policy Act (SEPA). Specific requirements for the EIS system may vary from State to State.

New salmon farm developments are subject to a maximum of 14 permits, depending on the State, the most important being those issued under State Environmental Policy Act (SEPA), National Environmental Policy Act (NEPA) (note that compliance with the permit process does not imply automatic compliance with NEPA, (Glasson *et al.*, 1999). Biological Assessments (BA) are also required for United States Army Corps of Engineers (USACE), Section 10 permits (assures protection of public interest, including navigation, water safety and water quality) (Amos and Appleby, 1999). USACE distribute the BA's to other agencies that have jurisdiction over permitting, such as the National Oceanic and Atmospheric Administration, (NOAA) and the United States Fish and Wildlife Service (USFWS). National Marine Fisheries Service administers the Endangered Species Act (ESA) for anadromous salmonids. ESA may require commercial salmon farmers to obtain permits to take fish for their use due to the impact on listed species (Amos and Appleby, 1999).

The Clean Water Act (CWA, 1977) is the primary legislation dealing with the protection of surface water quality, through application of a number of regulatory and non-regulatory tools. These tools[34] are employed to achieve the broader goal of restoring and maintaining the chemical, physical and biological integrity of the nation's waters such that they support "protection and propagation of fish, shellfish, wildlife and recreation in and on the water". The United States of America Environmental Protection Agency (EPA) is the primary federal administrative agency for both acts. The CWA is enacted through a permit process and this has become the main method for evaluating environmental impacts.

The CWA prohibits the discharge of pollutants from a point source except when authorized through a National Pollutant Discharge Elimination System (NPDES) permit[35]. The primary aim of the NPDES is to protect and improve water quality by regulating point source discharges. For the purposes of the NPDES, the EPA define finfish farms in the Concentrated Aquatic Animal Production (CAAP) Point Source category, and thus subject to the NPDES permit system. Routine environmental monitoring of salmon farm sites is conducted under the NPDES permit system and is administered at State level.

In 2004 the EPA established Effluent Limitation Guidelines (ELGs) and New Source Performance Standards for the CAAP Point Source category. Any net pen facility producing 100 000 lbs (~45 tonnes) or more of fish per year is deemed to be subject to

[33] www.epa.gov/epahome/laws.htm
[34] www.epa.gov/watertrain/cwa
[35] cfpub.epa.gov/npdes/

the ELG's. All such facilities are required to develop and maintain a best management practice plan detailing how the ELG requirements will be achieved (EPA, Aquatic Animal production Industry Effluent Guidelines 2004[36]). The CAAP regulatory and permitting programme is usually administered at State level, on approval from the EPA.

Two States are involved in salmon net-pen culture – Washington and Maine. Much of the regulatory authority for aquaculture and environmental assessments is devolved to the State agencies and in some cases local county authorities.

Regulatory authorities involved in management of salmon aquaculture in Washington State were summarized by Amos and Appleby (1999) (Box 7). The EIS process works under a programmatic EIS system that was established in Washington in 1991 (J. Rensel, personal communication). In Washington State the Department of Ecology has responsibility for monitoring and compliance of salmon culture operation. An

BOX 7

Agencies and regulations involved in management of aquaculture in Washington State

Washington Department of Fish and Wildlife (WDFW) - management and regulatory authority over all free-ranging fish in the State. WDFW authority over commercial fish culture in State waters is restricted to disease control and protection of wildlife in general.

- The Finfish Import and Transfer Permit (WAC 220–77–030) assures that diseases, pests and predators are not introduced or transferred.
- Hydraulic Project Approval (RCW 75.20.100, WAC 220–120), or HPA, assures that all construction projects ensure protection of wildlife and habitats.

Washington Department of Ecology (WDOE) - regulatory authority over discharges of pollutants into State waters for the protection, preservation and enhancement of the environment.

- The National Pollution Discharge Elimination System Permit (40 Regulation CFR, Part 122.21), or NPDES, assures compliance with State and federal water quality laws.
- The Water Discharge Permit (RCW 90.48) assures that discharges and wastes do not adversely affect water quality and standards. Under the Clean Water Act and the Water Pollution Control Act, WDOE can take regulatory action against net-pen operators who allow Atlantic salmon to escape.

Washington Department of Natural Resources (WDNR) - regulatory authority over State-owned aquatic lands, extending over lands covered and exposed by the tide.

- The Aquatic Lands Lease (RCW 79.90–79.96), or ALL, assures the specification of all uses of the land and the proposed facilities.

Local county authorities - act as lead agencies for applying the environmental policies of the State and the management of their respective county shorelines.

- The State Environmental Policy Act (RCW 43.21C, WAC 197–11), or SEPA, assures consideration of social and environmental impacts of proposed actions.
- The Shoreline Management Act (RCW 90.58), or SMA, assures appropriate and orderly development of State shorelines, management of their uses and preservation of their natural character.

WDFW, WDOE and WDNR jointly provide guidance to state and local agencies on siting farms in order to avoid adverse impacts on the environment.

[36] www.epa.gov/guide/aquaculture/

NPDES permit is required for all farms producing in excess of 20,000 lbs of salmon per year. "Recommended Interim Guidelines for the Management of Salmon Net-pen Culture in Puget Sound", as prepared by the SAIC (Science Applications International Corporation), have been adopted as the basic requirements for environmental site study and routine monitoring of environmental performance (Weston, 1986).

In the State of Maine, Aquaculture Lease Regulations[37] are administered by the Department of Marine Resources (DMR). For discharge applications, DMR works in conjunction with the Department of Environmental Protection, DEP (State of Maine), to ensure that requirements, at State and federal level, are adhered to. Developers for new salmon net pen sites must apply for a standard aquaculture lease[38] permit. This application details the requirements for the Environmental Baseline Field Survey (part 4 of Application Information requirements). The application is designed to facilitate the processing of aquaculture applications and is used jointly by DMR, DEP and USACE. Salmon net pen facilities require a permit under the Maine Pollutant Discharge Elimination System[39] (MePDES), which is administered at State government. This permit details the requirements for routine monitoring of salmon farm environmental performance.

Voluntary systems

Two main codes of practice for the aquaculture industry exist in the United States of America. The Code of Conduct for Responsible Aquaculture Development in the United States Exclusive Economic Zone[40] was devised by the NOAA Fisheries Service in collaboration with a number of stakeholders in 2000. The code provides a set of principles and standards that are applicable to all production systems and helps promote consistency across the industry. Among its main objectives are the promotion of marine stewardship and the establishment of standards to manage environmental issues associated with the industry.

The Saltwater Salmon Net-pen Operations Code of Conduct[41] was devised by the Washington Fish Growers Association (WFGA) in 2002. The code encompasses a number of general principles, including the protection and conservation of marine ecosystems and to take all reasonable measures to minimize impacts on the environment.

CONCLUSIONS

All of the countries examined have legislation in place to ensure that consideration of the environmental consequences of a proposed new salmon farm is mandatory. There are relatively minor variations between countries in the type of information that must be evaluated within an Environmental Statement (or other similar document that contains the product of the EIA process). In all cases assessments of benthic impact, eutrophication and damage to important habitat must be considered. Considerations of sea lice transmission to wild populations, disease transmission between farms and the consequences of escapes are now seen as extremely important. Genetic interactions with con-specifics is not likely in Pacific or Southern Hemisphere countries where Atlantic salmon are non-native and do not in general successfully breed, but transfer of parasites is an issue, particularly in British Columbia.

All the countries included in this study regulate the operation of salmon farming through a system of licences or permits to which various levels of environmental monitoring are appended. Supplemental to this is a series of voluntary codes of practice, summarised in Table 2 below. The most complex regulatory system is that found in the United States of America, with farmers requiring up to 14 different

[37] www.maine.gov/dmr/aquaculture/Chapter02.pdf
[38] www.maine.gov/dmr/aquaculture/documents/StandardFinfishApplication07.pdf
[39] www.maine.gov/dep/blwq/docstand/aquaculture/MEG130000.pdf
[40] www.nmfs.noaa.gov/trade/AQ/AQCode.pdf
[41] www.wfga.net/conduct.asp

permits, issued from different regulatory authorities. The simplest approach is found in New Zealand, with farmers applying for a single licence, the responsibility devolved down to the Regional Council. New Zealand and Chile are the only countries to define areas were salmon farming is permitted and where it is prohibited, although Norway has a relatively strong system of Coastal Zone Management and Scotland, together with several other countries, has defined areas where development of salmon farming (or its expansion if already existing) is precluded.

In the United Kingdom, some have argued that the current dual process, where the planning and environmental pollution aspects are separated, makes the process of applying for a new fish farm unnecessarily cumbersome and expensive. Others have argued that the planning and pollution functions have distinct ends and so have to remain separate and farmers often pursue both processes in parallel, even though the planning application would be unsuccessful if the pollution consent was not granted. In general, although a "one-stop-shop" may reduce bureaucracy for the farms, having a clear separation of different functions should ensure that no important aspect of a proposed development is missed. However, too much sectoral regulation, as appears to be the case in the United States of America and also in some other countries, may preclude changes in the industry that may have net environmental, as well as socio-economic, benefits.

TABLE 2

Summary of the voluntary codes of practice followed in the study countries

Country	Voluntary Agreements/Codes of Practice	Devised by	Web-link Source
Norway	None		
United Kingdom -Scotland	Code of Good Practice for Scottish Aquaculture (2006)	Scottish Finfish Aquaculture Working Group	www.scottishsalmon.co.uk/aboutus/codes.asp
Ireland	Single Bay Management (SBM) (1992)	Overseen by Irish Sea Fisheries board (BIM)	www.bim.ie/templates/text_content.asp?node_id=244
	Co-ordinated Local Aquaculture Management System (CLAMS) (1998)		
	Environmental Code of Practice for Irish Aquaculture Companies and Traders (ECOPACT) (2003)		www.bim.ie/templates/text_content.asp?node_id=700
United States of America	Code of Conduct for Responsible Aquaculture Development in the United States Exclusive Economic Zone (2000)	NOAA Fisheries Service	www.nmfs.noaa.gov/trade/AQ/AQCode.pdf
	Saltwater Salmon Net-pen Operations Code of Conduct (2002)	Washington Fish Growers Association (WFGA)	www.wfga.net/conduct.php
Canada	British Columbia Salmon Farmers Association Code of Practice (2005)	British Columbia Salmon Farmers Association (BCSFA)	www.salmonfarmers.org
	Environmental Policy and Code of Practice (2004)	New Brunswick Salmon Growers Association	www.nbsga.com/articles/2004-CodesandPolicyJune2004CompleteDocument(1).pdf
Chile	Clean Production Agreement Sustainable Production Agreement Integral Management System	SalmonChile	www.salmonchile.cl/frontend/seccion.asp?contid=&secid=6&secoldid=6&subsecid=141&pag=1
	Code of Best Practices for Salmon Farms (CPBA)	Fundación Chile	
New Zealand	National Environmental Code of Practice, (2007/2008).	New Zealand Aquaculture Council	www.Salmon.org.nz/Sector_Strategy_final_low_resolution.pdf

EIA and Environmental Monitoring in Practice

In this section we examine the practical application of EIA and environmental monitoring for marine salmon farming in terms of data collection, sampling analysis, standards, quality assurance etc. For each country a brief summary of the methods used in generic terms is given.

CANADA

Responsibility for environmental assessment and monitoring are based at the provincial level. Salmon aquaculture operations are found in four provinces – British Columbia, New Brunswick, Nova Scotia and Newfoundland. In New Brunswick, 95 percent of the salmon sites occur in the Bay of Fundy, constituting 90 percent Atlantic Canadian salmon production. This report therefore concentrates on British Columbia in the west and New Brunswick in the east.

In New Brunswick, the Department of the Environment (NBDENV) has primary responsibility for environmental monitoring and compliance. Monitoring is usually carried out by third party service providers and consultants.

Within the EMP, the Environmental Management Framework has a number of components with the ultimate aim of providing maximum protection to the environment (NBDENV 2006a). This includes the marine environmental quality objectives (MEQO), as applied to the marine finfish aquaculture industry. Oxic site condition, as determined by sediment sulphide concentration, is used as the MEQO for finfish aquaculture site classification. This applies to the benthic conditions in the area of the cage structures and lease area. Classification is based on the mean sediment sulphide concentration determined during the annual monitoring programme (between August and October), as detailed in Table 3. An Environmental Effects Management Framework (EEM) component has been devised in support of a Performance Based Standards (PBS) approach to compliance and regulation of marine environmental quality. The process relies on a tiered monitoring and management system based on compliance with the MEQO, with monitoring efforts and management requirements increasing as the level of impact increases. Details are provided in Table 3. The

TABLE 3
Classification of marine finfish aquaculture sites by sediment sulphide concentrations, as applied in New Brunswick

Site Classification		Sediment sulphide concentration	Responsive management decision framework	
Oxic	Oxic A	0 – 750 µM	Tier 1 monitoring**	Adhere to Operational Best Management Practices*
	Oxic B	750 – 1500 µM		
Hypoxic	Hypoxic A	1500 – 3000 µM	Tier 1 monitoring**	Adhere to Operational Best Management Practices, including appropriate Adjustments to the practices*
	Hypoxic B	3000 – 4500 µM	Tier 1, 2 monitoring**	Adhere to Operational Best Management practices, including appropriate Additional measures*
	Hypoxic C	4500 – 6000 µM	Tier 1,2,3 monitoring**	Adhere to Further enhanced Operational Best Management Practices*
Anoxic	Anoxic	> 6000 µM	Tier 1,2,3 monitoring**	Response measures to be decided in consultation with ASERC.

* Refer to Environmental Management Program for the Marine Finfish Cage Aquaculture Industry in New Brunswick (NBDENV, 2006a).
**See SOP (NBDENV, 2006b)

EMP gives full details on the Operational Best Management Practices to be adopted according to the level of compliance with the MEQO (NBDENV, 2006a).

"Standard Operating Practices for Environmental Monitoring of the Marine Finfish Cage Aquaculture Industry in New Brunswick" (SOP) have been devised and describes how monitoring should be carried out according to the monitoring tier (NBDENV, 2006b). The number of transects and sediment samples required is determined by the number of fish on site at the time of monitoring and the water depth at the site, as follows:

Sites of less than 30.5 m depth:

- One transect and three sediment samples per 100 000 fish;
- Minimum of 2 transects and 6 sediment samples for 1 – 200 000 fish.

Sites in a depth greater than 30.5 m:

- No transects to be laid but 3 sediment samples per 100 000 fish;
- Minimum of 6 sediment samples for 1 – 200 000 fish.

Guidance is also provided on the positioning of transects and sediment samples in relation to the cage array and individual cages, according to monitoring tier (see SOP, NBDENV, 2006b). Annual monitoring consists of video surveys along the transects (as stipulated by the monitoring tier) and the required sediment samples (as described above). Details of the components of each component are described in Table 4, however, the SOP should be consulted for full details (NBDENV, 2006b).

In British Columbia, provisions for environmental monitoring are contained in the Ministry for Environments Finfish Aquaculture Waste Control Regulation 2004 (FAWCR). In collaboration with the Ministry of Water, Land and Air (MWLA), Protocols for Marine Environmental Monitoring have been developed to facilitate application of FAWCR[42] Available details on the sampling protocols are given in Table 5. Baseline monitoring is performed at potential production sites prior to the commencement of construction and stocking. Operational monitoring protocols are applied to sites already in production.

Baseline Monitoring must be carried out in accordance with Schedule A (Baseline Inventory) of FAWCR[43].

Operators in BC are required to carry out routine monitoring at all sampling stations within 30 days of peak finfish biomass for each production cycle. In cases where the cage array has been relocated within the production cycle, the vacated site must be

TABLE 4

Components of the annual monitoring program conducted in New Brunswick, as detailed in the *Standard Operating Practices for the Environmental Monitoring of the Marine Finfish Cage Aquaculture Industry in New Brunswick*, (NBDENV, 2006b)

Monitoring component		Methodology	Determinand
Video survey		To be carried out along transects where appropriate Collection of all diver collected cores to be recorded Sea floor observation at each end of transects1	Seafloor observations as follows; Approximate sediment thickness; sediment colour; sediment consistency; surface consolidation; gas bubbles; % Beggiatoa coverage; presence of feed and faeces; macrofauna/flora; presence of detritus and fouling organisms.
Sediment samples	< 30.5 m depth	Cores to be collected by diver Minimum disturbance to cores is desirable. Clear cores 30 cm x 5 cm. Cores to be pushed into a depth of 10 cm	**Redox** Redox potential to be determined within the top 2 cm for each core or grab sample1
	> 30.5 m depth	Gravity corer for silt and clay sediments Heavy grab for other sediments Three cores or grabs per sample location	**Sulphide** A 5 ml subsample from the top 2 cm (after redox analysis) for sulphide determination1

* Full details provided in SOP. SOP also gives details of any deviations from the details provided (i.e. differences between monitoring tiers). References to full technical documents are available from NBDENV.

[42] www.env.gov.bc.ca/epd/epdpa/industrial_waste/agriculture/pdfs/reg_protocols.pdf

[43] www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/256_2002.htm#schA

TABLE 5

Sampling methodology employed in British Columbia, Canada, as detailed by Protocols for Marine Environmental Monitoring (MWLA)

Determinand	Sampling equipment	Sampling location	Spatial scale	Replicates
Baseline monitoring				
Class abundance and richness of megafauna	transect	Across entire site Reference stations*	Length /width of site At least 100 m long	Enough to identify biophysical characteristics to 50 m resolution two at each station (One transect should run perpendicular to the shore)
Class abundance and richness of macrofauna	quadrat	Across entire site Reference stations	1 x 1 m (nine 33 x 33 cm sections) as above	Enough to represent each substratum Five at each station
S^{2-}, E_h, TVS or TOC, SGS, Cu or Zn,	Petit-Ponar, Ponar, Smith-MacIntyre, van Veen grab	All stations	Any size	Three grabs per sediment type for each probable footprint. Minimum five grabs if only one sediment type present
Species richness and abundance of infauna and epifauna	Smith-MacIntyre, van Veen grab	All stations	0.1 m^2	Three grabs per sediment type for each probable footprint. Minimum five grabs if only one sediment type present
Operational monitoring				
S=, E_h,	Petit-Ponar, Ponar, Smith-MacIntyre, van Veen grab	All stations – perimeter of cage array, 30 m from 0 m station, perimeter of tenure and reference stations. Transect should be parallel to prevailing current	Any size	Three grabs at all stations. If mean S^{2-} value is above 1300 µM additional two grabs should be obtained from that station for S^{2-} and Eh.
TVS or TOC, Cu or Zn,	See as for S^{2-}	Only stations at perimeter of cage array and reference station	Any size	Three grabs at each station located at perimeter of cage array and at each reference station
SGS	See as for S^{2-}	Only stations at perimeter of cage array and reference station	Any size	One grab at each station located at perimeter of cage array and at each reference station
Family richness and abundance of infauna and epifauna	Smith-MacIntyre, van Veen grab	All stations	0.1 m^2	five grabs at each station. Three at each reference station

* Reference stations for Baseline Monitoring – should be 0.5 - 2.0 km from facility and must be 0.5 km apart. The mean depth at the reference station should be within 20 percent of the mean depth of the tenure. Characteristic and influences at the reference stations should be similar to that of the tenure

monitored within 30 days of the relocation. If free sulphide concentration is found to exceed specified levels the operator must repeat sulphide monitoring and undertake sediment biological sampling. Monitoring and additional sulphide monitoring should be carried out in accordance with Schedule B (Operational Monitoring) of FAWCR[44].

The protocols for marine monitoring used to facilitate FAWCR used in BC also provide guidance on statistical procedures to be used in interpretation of baseline and operational monitoring data (MWLA, 2002)[45].

In New Brunswick environmental monitoring field measurements are carried out be consultants or third party service providers. In British Columbia professional biologists carry out field surveys. These professionals may be consultants or industry staff. The Ministry of the Environment (MOE), British Columbia, carries out annual benthic audits are certain sites.

Ecological standards

Concentration of free sulphides in pore water is used as an environmental standard in British Columbia, through FAWCR.

[44] www.qp.gov.bc.ca/statreg/reg/E/EnvMgmt/256_2002.htm#schB

[45] www.env.gov.bc.ca/epd/epdpa/industrial_waste/agriculture/pdfs/reg_protocols.pdf

Marine Environmental Quality Objectives (MEQO) have been set in New Brunswick for sulphide concentrations in soft sediments as follows (see above for more detail):

- Oxic A – 0 – 750 µM
- Oxic B – 750 – 1 500 µM
- Hypoxic A – 1 500 – 3 000 µM
- Hypoxic B – 3 000 – 4 500 µM
- Hypoxic C – 4 500 – 6 000 µM
- Anoxic 0 > 6 000 µM

Quality assurance

British Columbia, through FAWCR, has environmental standards based on the concentration of free sulphide. An approved training course on the determination of free sulphide is provided to relevant personnel from consultants, industry and regulatory agencies, as a means of providing some Quality Assurance/Quality Control (QA/QC). There are fewer QA provisions for other parameters other than those provided by the commercial labs used to carry out analytical work (i.e. accreditation schemes). The Ministry of the Environment (MOE) carries out annual benthic audits are certain production sites.

In New Brunswick the Environmental Monitoring Program has an auditing component, which is carried out by DENV. A minimum of 20 percent of finfish aquaculture sites are audited annually as part of the auditing programme. This process is to ensure that the regulatory agencies are receiving accurate and reliable information on the environmental conditions at culture sites and ensures that procedures in the SOP are being adhered to (NBDENV, 2006a).

Modelling approaches used

In British Columbia, DEPOMOD (Cromey *et al*,. 2002a; 2002b) is used to predict the aerial extent of the 5 g/C/m^2/day contour as an indication of the area of maximum impact from culturing operations. DEPOMOD is also used in cases where farms are being re-sited to avoid conflict with valued marine resources. In New Brunswick, DFO may use DEPOMOD in current and depositional modelling studies.

CHILE

Through RAMA, The Environmental Regulation on Aquaculture (2001), all farms entered into the Environmental Impact Assessment System (SEIA) are required to carry out a Preliminary Site Description (PSD). The methodologies to be applied during the PSD are provided for in Resolution 404/2003[46]. In addition, an Environmental Information report is required from all farm sites at a specific time, as part of the routine monitoring. This report should provide information on the environmental condition of the farm site, (water quality and sediment parameters within the sedimentation area) at the time of annual maximum biomass.

The regulation focuses on maintenance of aerobic conditions in the sediment and states that authorization for an aquaculture site will only be approved where the PSD indicates that the sediment will remain aerobic in the future (RAMA, Article 17). The owner/operator of the site must ensure that aerobic conditions are maintained at the sea floor surface (RAMA article 17). The methodologies used in the PSD are detailed in Table 6.

The system is based on the categorisation of the farm and this determines the parameters to be measured in the PSD and Environmental Report. The five categories are described in Box 8. The parameters required, according to the farm category, are detailed in Box 9.

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[46] www.subpesca.cl/docs_ingles/Resolution_N404_english.pd

TABLE 6
Methodologies to be applied to Preliminary Site Descriptions and Environmental Information in Chile, as directed by Resolution 404/2003

Determinand		Sampling equipment		Sampling Stations		Replicas/ timings	Notes
Current		Acoustic Doppler current profiler		To be measured 1 m from the seafloor in the middle of the farm site.		Readings every 5 mins for at least 4 days	
				Water column divided into ten layers, speed and current to be measured in each		Readings every 5 mins for an entire tidal cycle (at least)	
Bathymetry	Cat 1 & 2	Lead line		Depth to be measured at each vertex of a 25 m x 25 m grid over the site			Bathymetric profile to be drawn with 10 m isobaths. To be presented along with a site plan.
	Cat 3,4 & 5	Continuous echo sounder		Entire area of site should be measured			
Visual registry	**PSD**	Diver operated digital recording, or be ROV		Two transects, running from furthest vertexes of site and passing through mid point		Minimum of ten minute recording for each transect	VHS format. Should describe sediment, presence of micro-organisms, presence of gas bubbles
	EI			Visual register of sedimentation area. 2, 100 m perpendicular transects. Should be under cage array with maximum biomass.			
Sediment granulometry		Sediment samples obtained using a grab with 0.1 m^2 bite	130 g, top 3 cm	**PSD**. The licensed operating area should be divided into quadrants of 1 hectare (100 m x 100 m). Each vertex is deemed to be a sampling station **EI.** At least three stations within area of sedimentation, with maximum biomass levels should be sampled. In addition to this two reference stations should be sampled.		No replicates required for **PSD** Resolution 404/2003 states 3 replicas at each sampling and reference station for the EI	Detailed methodology provided in resolution 404/2003
Organic matter content			100 g, top 3 cm				
Benthic macrofauna			1.0 mm sieve				ID to family or species level. Each species or family to be weighed.
Redox and pH		From grab or corer	Top 3 cm				pH probe temperature compensated
Dissolved oxygen	**PSD**	In situ, ex situ (from water sampler)		Centre of site	To be determined every 5 m, from 10 m to 1 m above seafloor	To be carried out once for **PSD**, then every two months during production.	Concentration and saturation to be determined
	EI			Beneath two cages			

PSD – Preliminary Site Description, **EI** – annual Environmental Information

The resolution states that sampling stations (as described in Table 6) should only be determined for areas of soft sediment (RAMA, 2001). Where hard substrate is present a visual register should be carried out (see Table 6). Sites where there are both soft sediment and hard substrate should use both sampling methodologies where appropriate.

In addition, RAMA requires that each farm operation must formulate a contingency plan. This should provide details of what action will be taken in the event of circumstances arising that may cause environmental damage. The plan should consider a number of possibilities, including large-scale mortality or escapes and accidental loss of food and other material[47].

Site evaluations and annual monitoring is carried out by consultants hired by the farmers.

Environmental quality standards

The primary environmental quality objective is based on the maintenance of aerobic sediment conditions. When anaerobic conditions are detected there is a mandatory mitigation strategy where production levels must be decreased by 30 percent until aerobic conditions are restored.

[47] www.subpesca.cl/docs_ingles/RAMA_english.pdf

BOX 8

Farm categorisation as described in Resolution 404/2003 of RAMA

Category 1
- Extensive suspended production systems with annual production equal or less than 300 tonnes. Located over soft sediment in 60 m or less.

Category 2
- Suspended production systems with annual production between 301-750 tonnes. Located over soft sediment in 60 m or less.
- Intensive production systems with annual production equal or less than 50 tonnes. Located over soft sediment in 60 m or less.

Category 3
- Extensive production systems with annual production greater than 750 tonnes. Located over soft sediment in 60 m or less.
- Intensive production systems with annual production greater than 50 tonnes. Located over soft sediment in 60 m or less.

Category 4
- Intensive production systems located in hard or semi hard substrate in 60 m or less.

Category 5
- Production systems located in depths greater than 60 m.

BOX 9

Environmental determinands required for the PSD, according to category

Category 1
- Bathymetry
- Organic matter in sediment

Category 2
- Bathymetry
- Organic matter in sediment
- Sediment granulometry
- Benthic macrofauna

Category 3
- Bathymetry
- Organic matter in sediment
- Sediment granulometry
- Benthic macrofauna
- Redox and pH in sediment
- Eulerian current
- Dissolved oxygen profile of water column

Category 4
- Bathymetry
- Eulerian current
- Visual register

Category 5
- Bathymetry
- Eulerian current
- Dissolved oxygen profile of water column

Quality Assurance

Certification programs are currently under consideration. Implementation of appropriate schemes is planned for the end of 2007.

Modelling approaches

There may be cases where SubPesca would request the use of modelling approaches. They would be used to help determine the area of maximum sedimentation[48]. A more comprehensive inclusion of modelling approaches is expected in 2007.

IRELAND

Monitoring of the aquaculture industry is carried out by the self-monitoring and confirmation approach, where environmental reports are produced by farm operators and a proportion of sites are independently assessed by scientists from the Marine Institute, for verification purposes.

[48] www.subpesca.cl/docs_ingles/Resolution_N404_english.pdf

Monitoring of the environment around finfish operations is carried out by a number of methods:

- Water column monitoring is carried out on a monthly basis from December to March in each year. Sampling is conducted at stations located among cage structures and at control stations away from the cages. Measurements of temperature and salinity are made and samples are taken for ammonia, nitrate, nitrite and phosphate.
- Benthic sampling is carried out within 30 days of peak biomass at most sites. Sampling is carried out according to three levels of investigation:
  - Level 1 – a visual assessment of transects through the site;
  - Level 2 – a visual inspection of transects through each site with accompanying Redox (reduction-oxidation potential) measurements;
  - Level 3 – a full faunal analysis of sediments throughout the sites.

All sites are assessed against sedimentary conditions at control locations away from the farm. This Programme is applied to assess compliance with the conditions stipulated in individual license conditions.

Techniques for water, sediment and biota sampling, sample storage and transport requirements and analytical protocols are designed to be consistent with international aquaculture monitoring programmes. The parameters measured and sampling methodology for the regulatory programme are currently being reviewed. The criteria which are currently applied are summarised in Table 7.

Sea lice monitoring

The Marine Institute is charged with carrying out regular inspection of sea lice levels on finfish farms around the country in accordance with protocols set out under the National Sea Lice Monitoring Plan (Box 10). All fish farms undergo lice inspections 14 times per year. One lice inspection takes place each month at each site where fish are present, with two inspections taking place each month during the spring period of March to May. Only one inspection is carried out in the December/January period. The results of the sea lice surveys are reported to stakeholders (DCMNR, BIM, Irish Salmon Growers Association, individual farms and Regional Fisheries Boards) on a monthly basis and are published annually by the Marine Institute with detailed monitoring results by farm (Status of Irish Aquaculture, 2004[49]).

Water column

Water column monitoring is also carried out by the Marine Institute, however the majority of the monitoring is in relation to shellfish aquaculture. There are a series of EQS's set for salmonid water quality and these are detailed in Table 7. The water column parameters to be measured and the frequency of sampling is stipulated in each individual aquaculture licence, dependant on the particular sensitivity of the receiving environment. Three water column parameters are monitored at all salmon farms: dissolved oxygen, chlorophyll a and dissolved inorganic nutrients (nitrate, nitrite, phosphate), on a monthly basis.

Benthic impact

The benthic monitoring programme adopted by Ireland is based largely on the programme implemented by the United Kingdom of Great Britain and Northern Ireland based Scottish Environmental Protection Agency. There are three levels of monitoring programme targeted at the benthic impacts of salmon farms:

- Level 1: Video/photographic and visual observations/recordings taken at sample stations directly underneath the cages, at the edge of the cages, at 10 m, 20 m, 50 m and 100 m downstream at peak biomass period.

[49] www.bim.ie/templates/reports.asp?node_id=268

TABLE 7
Irish environmental monitoring methodology

Area of Impact		Sampling Location	Determinand	Methods employed	EQS	Frequency
Sea Lice*		Presence of ovigerous sea lice on farmed fish in cages	Number of lice per fish	Visual quantitative count. 30 fish sampled form 2 cages, one selected at random, one inspected each time	2 ovigerous lice per fish, (June-February). 0.3-0.5 ovigerous lice per fish (March-May)	14 times a year. Fortnightly during March, April and May.
		Presence of mobile lice in cage	Number of mobile lice in cage	Visual quantitative count	When numbers are high even if there are no ovigerous females present.	
Water Column		Sampling stations along a transect agreed by the Marine Institute in accordance with Single Bay Management and CLAMS plans. All stations are logged using Differential Geographic Positioning System with an accuracy of +/-0.5m	Temperature Ammonia Nitrite mg/l Nitrate Phosphate Salinity	Samples are collected from water directly beside the cages at the surface, mid-depth and 1m above the sea bed.		Monthly during December to March each year. Report submitted to DCMNR by 30 April each year
Benthic	Level 1	Numerous stations directly under the cages, at the edge of the cages, along two transects at right angles to each other at +/-10m, +/-20m, +/-50m and +/-100m and a control site at least 500m distant from the cages.	Presence of bacterial mats, feed pellets, litter, gas bubbles, anoxic areas, fauna, macro-algae, sediment colour and texture	Video and/or underwater photography. Observational survey by divers.	Yes	Annually, during peak biomass or within 30 days after end of harvesting a year class. Report submitted to the DCMNR by end November each year.
	Level 2		Level 1+ redox	In addition to the above a minimum of 3 redox measurements are taken at each station using a platinum electrode.	Yes	
	Level 3		Level 2 + macro-fauna	Biological samples taken by grab or core, sieved through 1mm sieve. Specimens identified to species level, number of species and abundance recorded.	Yes	

* www.marine.ie/NR/rdonlyres/0210E4CE-F4AA-47F2-8D51-EFEA10A4C4EB/0/MonitoringProtocol3.pdf

BOX 10
Irish Sea Lice Management Plan

In 1991, in response to concerns about the possible impacts of sea lice from salmon farms on wild populations of sea trout, a sea lice monitoring programme was initiated by the Department of the Marine. In 1992/1993 the programme was expanded and culminated in the publishing in May 2000 of the "Offshore Finfish Farms - Sea Lice Monitoring and Control Protocol" (Department of the Marine and Natural Resources, 2000).

The purpose of the National Sea Lice Monitoring Plan is to:

- provide an objective measurement of infestation levels on farms;
- investigate the nature of the infestations;
- provide management information to drive the implementation of the control and management strategy; and
- facilitate further development and refinement of control and management strategies.

The management strategy for sea lice control has five principal components:

- separation of generations;
- annual fallowing of production sites;
- early harvest of two sea-winter fish;
- targeted treatment regimes, including synchronous treatments; and
- agreed husbandry practices (including fish health, quality and environmental issues).

Together, these components work to reduce the development of infestations and to ensure the most effective treatment of developing infestations. They minimise lice levels whilst controlling reliance on, and reducing use of, veterinary medicines. When lice levels exceed pre-set treatment figures (the treatment trigger level), advice is given to treat the affected stock. These are designed to minimise any risk of transmission of sea lice from fish farms to wild sea trout stocks. The current treatment trigger level is 0.3 – 0.5 egg-bearing (ovigerous) female lice per fish during spring. Outside the critical spring period, the treatment trigger level is set at 2.0 egg-bearing female lice per fish. Where numbers of mobile lice are high, treatments are triggered even in the absence of egg-bearing females.

- Level 2: In addition to the above redox is measured at the sample stations.
- Level 3: In addition to 1 and 2, a quantitative and qualitative investigation of benthic macro-faunal invertebrates at the sample stations.

The level implemented will depend on the tonnage of fish at the site and the current speed (Table 8).

It is accepted that there will be an "allowable zone of impact" around the cages with three levels of acceptable impact: standard, transitional and light. The benthic conditions should not fall below these impact levels, which are assigned to specific zones from the cages (Table 9).

The benthic conditions 100 m from the cages should not be different from the control site conditions and the benthic conditions directly under the cages should not become

TABLE 8
Level of benthic monitoring to be carried out at salmon farms in Ireland depending on mean current speed and annual production (McMahon, 2000)

Production (tonnes)	Mean current speed (cm s^{-1})		
	<0.1	<0.5	>10
0 - 499	Level 1	Level 1	Level 1
500 – 999	Level 2	Level 1	Level 1
>1 000	Level 3	Level 3	Level 2

TABLE 9
Acceptable levels of benthic impact in the 'allowable zone of impact', Ireland, (McMahon, 2000)

Benthic conditions	Impact level		
	Standard 0 – 20m from cages	**Transitional 20 – 50m from cages**	**Light 50–100m from cages**
Visual observations	Scattered feed pellets	Occasional feed pellets	No feed pellets
Bacterial mats	Occasional patches	Absent	Absent
Fauna	Diverse with increasing number of species present. Stage II infauna predominate	Stage II communities dominate with greater diversity with distance from cage	Normal or Stage III community predominate
RPD	Not <1cm	>1cm	Ambient redox depth

anoxic. Should the monitoring results show that the benthic impact is unacceptable the farmer must submit a Benthic Amelioration Plan to the DCMNR.

NEW ZEALAND

The Australian and New Zealand Environment Conservation Council (ANZECC) have developed a set of guidelines that provide a framework for water quality monitoring[50]. These guidelines identify environment quality objectives, recommend indicators and detail the protocols and sampling strategy to be followed. They also include sea bed and sediment quality objectives. It is recommended that the online information should be consulted, as the applications detailed in this report are liable to change, especially as the current management of aquaculture in New Zealand has undergone a recent and comprehensive reforming process. New Zealand does not apply a generic approach to the monitoring of salmon farming, and the choice of which determinand to include and the frequency of the sampling program is at the discretion of the regional council and will be stipulated in the resource consent.

Due to the sectoral nature of aquaculture management in New Zealand and as responsibility has been devolved down to regional and local authorities the areas where salmon farms operate all apply different approaches and so will be considered separately. An overview of each area follows.

Big Glory Bay, Stewart Island

Salmon farms operating in Big Glory Bay will have been granted consents under the previous legislative arrangement, having been at the site since the early 1990s. Conditions attached to the original licence, granted in 1991, required records to be kept of level of production, the use of therapeutants, amount of feed used, periodic monitoring by divers of the sea floor under the farm and the prohibition of TBT use as an anti-foulant. The cages were to be at least 50m from the shore and in water at least 12m deep. Following a HAB in 1995, a nitrogen model was used to predict conditions and on the basis of this licence conditions were amended to include a restriction on the levels of nitrogen in the feed used on an annual basis. This effectively put an upper limit on the amount of food that could be discharged and was estimated for the Bay as a whole and was divided out among all licensees.

This approach was further refined in 1995 when a Bay-wide monitoring and management programme based on the nitrogen model was implemented. This programme included the nitrogen introduced into the system from the farm, either directly from feed input or released from the sediment on the sea floor, and also incorporated the nitrogen removed from the system from the increasing number of mussel farms. During the summer months, monthly samples of concentrations of nitrogen, phosphorus and dissolved oxygen are measured at locations in the Bay and outside in open water. An annual video survey of a transect running under the farm is

[50] www.environment.gov.au/water/quality/nwqms/pubs/wqg-contents.pdf

taken and the variation in the epifauna assessed qualitatively. The farmer also monitors methane and sulphide levels for operational purposes.

Akaroa Harbour

A salmon farm has been operating here since 1984 and has had the original licence converted to a coastal permit under the Aquaculture Reform Act (2004), valid until 2025. Two consents are attached to this permit; consent to discharge feed into the waterbody and consent for a refuge should a HAB occur at the farm site. The refuge area is diver surveyed to identify sensitive areas within the refuge where the farm may not locate to. The sea bed of the refuge area will be monitored during and after the cages have been relocated there. The accumulation of waste underneath the cages is monitored every six months by the regional council.

Marlborough Sounds

An annual monitoring programme is carried out on the six cage sites surveying the benthic and water column impacts.

Benthic monitoring

Qualitative and quantitative analysis of grab samples is carried out. A 'zones' approach is used to assess compliance with the resource consent conditions based on a conceptual model that identifies an acceptable level of benthic impact based on environmental quality standards. Three zones are identified in the vicinity of the farm where a certain level of impact is permitted. This zonation reflects site-specific conditions such as current flow and the dispersive pattern of farm wastes. Samples are collected beneath the cages and along a transect running down current from the farm. A control site is also sampled. Sub-samples are analysed for macro-fauna, grain size and organic content. Visual observations and semi-quantitative assessments are made on the depth of the redox potential discontinuity layer, sediment odour and texture. Zinc concentration of the sediment beneath the cages is also measured. Redox potential is measured using a platinum electrode, sulphides are measured using a silver/sulphide electrode probe. Video surveys by a remote operated vehicle of the sea floor below and around the farm are qualitatively assessed for epifauna and the presence of bacterial mats. In addition to the annual survey every two years a shallow sub-tidal/inter-tidal survey is conducted along two transects inshore of the farm.

Water column monitoring. The coastal permit holder routinely monitors dissolved oxygen concentrations in the water column as part of the operational procedures.

The ANZECC guidelines list biological assessment objectives for ecosystem protection that regional councils should apply and gives instructions on how to implement them (Table 10). The guidelines also list the impacts (or as referred to 'water quality issues' even though it includes benthic impacts), how to assess the level of impact, which determinand to use and the protocol to apply (Table 11). All determinands have trigger values assigned. Once the trigger value has been breached action is initiated to return the receiving environment to acceptable levels.

NORWAY

The licensing process applies a generic approach to all salmon farms. The license requires the farmer to record each month the operational activities of the farm at three levels of detail as listed in Table 12. These records are compiled annually into a report that is submitted to the Directorate of Fisheries, the enforcing agency.

Supplemental to the licensing records, a monthly sea lice report is submitted to the local District Veterinary Officer on the 15th of each month. Sea lice counts are taken fortnightly at sea temperatures greater than or equal to 4°C (Dow, 2004). Thresholds for late winter and early spring are currently 0.5 gravid females or two mobile lice per fish (Boxaspen, 2006).

TABLE 10
Biological assessment objectives for different management situations and the recommended methods and indicators, New Zealand

Assessment objective	Application	Recommended determinand	Essential or desired attributes of the determinand to be employed
Broad scale assessment of ecosystem 'health' (catchment, regional, or larger scale)	Water quality on a catchment or regional basis	Rapid bio-assessment	Comparative measures of biological community composition. Measure rapidly and cheaply, quick turn around of results Have a diagnostic value
Early detection of short or long term changes	Sites of special interest (potential point source pollution event)	Laboratory based: direct toxicity assessment Field based: biomarkers, bioaccumulation, spatial disturbance gradients in relevant quantitative biological indicators.	Sensitivity to the type of contaminant expected Respond and measure rapidly Demonstrate a high degree of constancy in time and space.
	Water quality on a regional basis in response to specific pressure	Rapid bio-assessment	Comparative measures of biological community composition. Measure rapidly and cheaply, quick turn around of results Have a diagnostic value
Biodiversity or ecosystem level response	Sites of special interest	Detailed quantitative regionally comparative investigations of communities possibly with species level taxonomic resolution. Direct and comparative measurement of the ecosystem	Direct measures of diversity (using species level identification). Direct measures of ecosystem function (community metabolism). Use of surrogate measures for ecosystem biodiversity where relationship between surrogate and biodiversity has been shown. Have a diagnostic value.
	Water quality at sites and on a regional basis	Direct and comparative measurement of the ecosystem process of concern Rapid bio-assessment	Direct measures of diversity (using species level identification). Direct measures of ecosystem function (community metabolism). Use of surrogate measures for ecosystem biodiversity where relationship between surrogate and biodiversity has been shown. Have a diagnostic value

TABLE 11
Assessing impact level, New Zealand

Environment quality issue	Suitable biological determinand or assessment approach	Protocol*
General inorganic (including metals) and organic contaminants. Early detection of short or longer term changes from substances in solution/ water column	Biomarkers (chemical/biochemical changes in an organism)	1B (i) (ii)
	Direct toxicity assessment	Section 8.3.6 (Vol 2)
General inorganic (including metals) and organic contaminants. Early detection of short or longer term changes from substances deposited (sediments).	'Whole sediment' laboratory toxicity assessment	2A Section 8.3.6
	Bioaccumulation/biomarkers (for organisms that feed through ingestion of sediment), other sub-lethal including behavioural responses.	2B (i) (ii)
Suspended solids in the water column	Sea grass depth distribution	6
Effects of organotins	Imposex in marine gastropods	9
Nutrient inputs	Sea grass depth distribution	6
	Frequency of algal blooms	7
	Density of capitellids	8
	In-water light climate	These indicators and protocols are not currently available in the guidelines, but are listed and considered to be easily and quickly developed with additional resourcing
	Filter feeder densities	
	Sediment nutrient status	
	Coral reef trophic status	
Broad scale assessment of ecosystem 'health' (non-specific degradation).	Habitat distributions	
	Assemblage distributions	

* The codes in this column refer to protocols that are listed by title in section 8.1.3 of Volume 2. Summary descriptions of these protocols with reference to important source documents are provided in Appendix 3, Volume 2 of the ANZECC Guidelines**.

** www.deh.gov.au/water/quality/nwqms

TABLE 12
Licence records, Norway, (after Maroni 2000)

Level	Record
Licence level	Handling and delivery of dead fish
	Purchases of ready-made feed and fish meal
	Consumption of net impregnating agents
Site level	State of health, diagnostic tests and treatment
	Number of lice on salmonids
	Use of medicinal products (type and name, quantity used and treatment period)
	Use of chemicals (type and name, quantity used and consumption period)
	Catches made during fishing for monitoring or recovery purposes (escapes)
Unit/sea cage level	Stocking (number, species, origin, stocking time and average live weight)
	Fish density kgm-3 (live weight)
	Net depth
	Consumption of feed
	Escapes
	Slaughtered quantity and quantity of dead/dying fish removed

Installation requirements

The NYTEK regulations were drawn up to address the environmental impacts arising from escaping fish. Salmon farm installations are assessed according to site-specific conditions. These are categorised according to wave height and current speed and the level of forces exerted on the cages. A dynamic model, 'ConMotion' is used to predict the forces at each site and creates a tension map for each site's cage infrastructure, informing on site-specific needs. Table 13 presents how the 25 different site classifications have been determined and how they are categorised according to the exposure level of the site. The category informs the specifications for all components of the installation. The NYTEK regulation certificate is valid for three years and the enforcing agency is the Directorate of Fisheries.

Environmental monitoring requirements

Around 15 percent of Norwegian salmon farms are inspected each year by authorised personnel from the Directorate of Fisheries. The inspection is based on the monthly records as stipulated in the license, the lice records and all measurements taken in accordance with the MOM system. A detailed evaluation of the environmental reports

TABLE 13
NYTEK regulation classification system, Norway

Classification of site conditions					
	Current velocity m/s				
Wave Height m	a	b	c	d	e
	0.3	0.5	1.0	1.5	>1.5
A 0.5	Aa	Ab	Ac	Ad	Ae
B1.0	Ba	Bb	Bc	Bd	Be
C 2.0	Ca	Cb	Cc	Cd	Ce
D 3.0	Da	Db	Dc	Dd	De
E >3.0	Ea	Eb	Ec	Ed	Ee

Site Category	Increasing current speed →					
1	Aa	Ab				Increasing wave height
	Ba					
2			Ac	Ad	Ae	
		Bb	Bc	Bd	Be	↓
	Ca					
3		Cb	Cc	Cd	Ce	
	Da					
4		Db	Dc	Dd	De	
	Ea	Eb	Ec	Ed	Ee	

for each farm is conducted and these findings are then compiled into a national report, which is cross-checked with other sources of information (Maroni, 2000). Environmental monitoring is carried out in accordance with Norwegian Standard NS9410 (investigations B and C) and NS 9423 (investigation C) by independent experts and consultants. The focus is on benthic impact with sediment samples being collected by grabs. Water column monitoring receives little attention, with oxygen concentration being the only water column parameter recorded in the C investigations. Table 14 summarises the parameters and methodology for the two monitoring investigations.

UNITED KINGDOM

Scotland has adopted a policy of self-monitoring with regular auditing of a proportion of all sites by the regulatory authority, SEPA. The monitoring strategy, sampling and program design is flexible and will vary depending on the site profile and sensitivities and is subject to regular reviews. SEPA provide a comprehensive set of guidelines[51] relating to all aspects of the required environmental monitoring and set Environmental Quality Standards (EQS). SEPA apply a limiting factor approach using predictive models, e.g. DEPOMOD (Cromey *et al.,* 2002a; 2002b). A pre-licence baseline study of the site is undertaken to determine site sensitivity allowing consent conditions to be matched to the carrying capacity of the location. Post-licence monitoring during the farm's operational phase occurs during pre-stocking, production fallowing and medicines application. Monitoring also occurs after removal or reduction of fish biomass to assess site recovery. The monitoring strategy is developed to monitor consent compliance and environmental assessment. Consent compliance monitoring is outlined in Box 11.

BOX 11

Consent compliance monitoring

- **Record returns**. These detail medicinal treatments, feed used and biomass at individual sites.
- **Cage inspections and record audits**. Inspection of records kept of stock held, medicinal treatments, chemical storage facilities, disposal facilities for dead fish and solid waste, net-washing facilities and disposal of net washings.
- **Discharge monitoring**. Samples of water from within the cages during chemical treatment may be analysed and compared to recommended concentrations.
- **Sampling of chemicals**. Samples will be taken of medicines and other chemicals.
- **Feed and fish tissue sampling.** Samples will be taken of feed and fish tissue, which will be analysed for residues.

Environmental monitoring is carried out to:
- validate and verify mathematical models;
- ensure EQSs are being met;
- measure impacts on the environment;
- assess the need for remedial action;
- audit the results of self monitoring.

The sampling strategy is developed to measure the environmental impacts that may arise from organic wastes from fish feed and fish faeces, nutrients in the water column and medicines and chemicals. Environmental monitoring may be carried out locally around the farm or regionally (a whole sea loch or coastal system) depending on the impacts under investigation.

[51] www.sepa.org.uk/pdf/guidance/fishfarmmanual.asp

TABLE 14
Norwegian environmental monitoring methodology

Zone		Determinand**		Methods employed	EQS		Frequency		Investigator
B	Local and intermediate	Presence of macro infauna		Quantitative assessment of sediment for presence or absence of macro infauna after 1mm sieve.	Yes.** Presence=0 Absence=1 Mean sample score - ≤0.5 EC 1-3 >0.5 EC 4		The frequency of the complete B investigation:		External consultant
							DEX1	Every second year	
		pH and redox		Electrodes inserted directly into sediment immediately after sampling in grabs Measurements are taken at 1cm depth.	Yes*** Mean score ≤1=EC1, <1≤2=EC2 <2 ≤ 3=EC3, > 3=EC4		DEX2	Every year	
							DEX3	Twice a year Spring and Autumn)	
		Sensory Sediment variables. Due to the subjective nature of these variables their scores are combined and combined EQS applied	Colour	Subjective visual assessment of sediment samples	No. Light grey, brown=0 Dk brown, black=2	Combined scores giving EC. Mean score as for pH and redox			
			Odour and consistency	Subjective olfactory assessment of sediment samples	No No smell=0 Slight smell=2 Strong smell=4				
			Gas ebullition	Quantitative assessment of sediment for presence or absence of gas bubbles	No Absent=0 Present=4				
			Sludge layer thickness	Top layer of overlying sludge measured through transparent core.	No 0-2cm=0, 2-4cm=1 4=6cm=2 6-8cm=3 >8cm=4				
C	Intermediate and regional	Quantitative and qualitative assessment of benthic fauna		According to NS9423, NS9410 and the Norwegian Pollution Control Authority	Yes. EQS are set according to NS9410 and by the Norwegian Pollution Control Authority.		At the discretion of the local authority.		Expert consultant
		Organic content of sediment							
		Particle size of sediment							
		Sensory sediment variables as in B investigation							
		Oxygen content of the water column							

* DEX = Degree of Exploitation, **Environmental Condition where EC 1-3 = acceptable conditions, EC4= unacceptable conditions. *** Based on a scoring system detailed in Hansen *et al,* (2001)
** In this report determinand is defined as a constituent or property of the environment which is determined through measurement or analysis

SEPA base environmental monitoring on the mixing zone concept. Within an "Allowable Zone of Effects" (AZE), a certain level of impact is permitted but higher environmental standards must be met outside the AZE thus giving two quality standards for several determinands. Two separate modelling approaches to assign the AZE are used for water column monitoring and sea bed monitoring. In all cases the sea bed AZE is determined by site specific criteria using the autoDEPOMOD modelling package. Previous to this the AZE was defined according to set limits developed according to ADRIS (1991), which for the water column AZE was 100 m in all directions from the cages and for benthic impacts was 25 m in all directions. This fixed AZE approach still applies to farm sites where consents were determined before the modelling approach was adopted.

Monitoring is scaled to farm size, hydrographic character and site sensitivity, with least monitoring being required from low biomass or highly dispersive sites. The environmental monitoring methodology as applied to water column and benthic impacts is outlined below.

Water column monitoring[52]

Water column monitoring focuses on nutrient levels, dissolved oxygen and medicines and chemicals. The frequency and level of detail involved is directly related to biomass of fish and the sensitivity of the receiving environment in relation to flushing time of the waterbody. The frequency of sampling and methodology employed is summarised in Tables 15 and 16. The recommended strategies for monitoring these are outlined below.

TABLE 15
Water column nutrient sampling intensity, United Kingdom

Farm biomass and site character	Survey level	Sampling location	Frequency
<1 000 tonnes	No regular monitoring required		
>1 000 tonnes flushing time < 3 days	SEPA sampling Category 1	4 stations: 1 up-tide from cages 1 beside cages 1 down-tide from cages 1 control	Bi-annually, 1 winter survey 1 summer survey
	Local operator sampling	4 stations: 1 25 m up-tide 1 at cages 1 25 m down-tide 1 control	Bi-annually, 1 winter survey 1 summer survey
>1 000 tonnes flushing time >3 days	SEPA sampling Category 2	8 stations: 3 up-tide from cages 1 at cages 3 down-tide from cages 1 control	Bi-annually, 1 winter survey 1 summer survey
	Local operator sampling	8 stations: 2 at 100m, 50 m and 2 5 m from cages, up-tide and down-tide 1 at cages 1 control	Bi-annually, 1 winter survey 1 summer survey

Nutrients

The recommended strategy for monitoring nutrient levels involves the following components:

- Define the boundaries of the waterbody being investigated.
- Ascertain flushing time, tidal volume and total volume where possible.

[52] www.sepa.org.uk/pdf/guidance/fish_farm_manual/annex/E.pdf

TABLE 16
Water column parameters and sampling methodology, United Kingdom

Determinand	Methods employed*	EQS
Salinity	Standard probe reading	<40
Temperature	Standard probe reading	No EQS
Ammonia	Standard colourimetric method	
Nitrate	Standard spectrophotometrically at 543 nm	168 µg/l
Nitrite	As nitrate	As nitrate
Phosphate	Standard spectrophotometrically at 850 nm	6.2 µg/l
Chlorophyll	Standard fluorimeter reading at 430 nm.	10 µg/l
Dissolved oxygen	Winkler titration or vertical profiles can be taken using a probe at 5 m intervals.	≥70% (average)
Copper		5 µg/l
Medicines and chemicals**		Yes

* At each station samples are taken at the top and middle of the water column, except for the deepest part of the basin and at the cages where samples are collected from 3 depths***.
** www.sepa.org.uk/pdf/guidance/fish_farm_manual/annex/A.pdf

*** www.sepa.org.uk/pdf/guidance/fish_farm_manual/annexE.pdf

- Use the United Kingdom of Great Britain and Northern Ireland Marine Fish Farm Database[53] to determine total consented biomass farmed in the system.
- Rank systems in order of biomass/flushed volume.
- Monitor peak winter nutrients (nitrogen and phosphorus) and chlorophyll according to ranking in sensitivity/biomass table.
- Assess nutrients and chlorophyll against standards included in the UWWT Directive, OSPAR agreements and other relevant standards.
- Review monitoring annually and increase or decrease according to monitoring results.

Dissolved oxygen

The recommended strategy for monitoring dissolved oxygen involves the following components:

- The extent of DO monitoring will be determined according to biomass and local hydrography.
- DO will be monitored on a coastal system basis.
- DO will be monitored in the area around the cages and the wider loch basin area.

Medicines and chemicals

Some environmental monitoring is carried out close to or within the cage and in specific locations from the cage group, but the main method of regulation is through predictive modelling. Water samples are used to check predictions. The use of vaccines has lead to a decrease in the use of anti-microbial agents and these are not viewed as a priority for monitoring. Copper levels, derived from anti-foulant treatments, outwith the AZE must comply with the EQS for this metal.

Sea bed monitoring[54]

Benthic monitoring operates within the following framework:

- Sea bed monitoring is done locally around cage groups.
- Monitoring requirements depend on site specific biomass and local hydrography.
- Sea bed monitoring is mainly carried out as self monitoring by the operator.
- SEPA audit a proportion of the operator's self-monitoring.

[53] www.sepa.org.uk/spri/index.htm
[54] www.sepa.org.uk/pdf/guidance/fish_farm_manual/annex/F.pdf

- Sediment standards are set in the AZE for the biological and chemical indicators[55].

Sediments are monitored for medicines and chemicals likely to accumulate for comparison with sediment action levels. Monitoring of the sea bed focuses on waste deposition, medicines and chemicals. The frequency and level of detail required is determined by which survey strategy is applicable. There are six categories of benthic survey, applied according to biomass and whether the location is a new site or an existing one and if in-feeds are used (Table 17).

The six survey categories differ in the number of sample stations incorporated in each (Table 18). All surveys, except the visual monitoring survey, are analysed for benthic infauna, redox (Eh), organic carbon, particle size analysis and a visual description of the sediment.

TABLE 17
Summary of sea bed monitoring strategies, United Kingdom

Biomass (tonnes)	New site	Existing site with increasing biomass and/or infeeds	Consent monitoring only
0-1000 *	Standard baseline	Standard or Site specific monitoring	Standard or site specific monitoring
>1000	Extended baseline survey	Extended or site specific monitoring	Extended or site specific monitoring

* A visual monitoring survey may be carried out for sites <500 T, those over hard substrates and any site were detailed visual data is required e.g. near natural heritage designations (SAC, SPA).

TABLE 18
Monitoring levels of the six survey categories, United Kingdom

Survey	Monitoring level
Visual monitoring survey	One 50 m transect running along the predominate current direction, with stations at 5m intervals. Video taken by diver or Remotely Operated Vehicle (ROV), still photographs taken at each station.
Standard baseline survey	Samples are taken from two stations, 100m apart, near the proposed location of the cages. Two reference stations are sampled outwith the proposed area (ideally 500 m – 1 km away).
Extended baseline survey	Samples are taken along two transects, one running down current, one up current, with stations at the cage edge, 50 m and 100 m away in both directions. Two reference stations are sampled outwith the proposed area (ideally 500 m – 1 km away).
Standard monitoring survey	Samples are taken from two stations lying along the current direction, one within 5 m of the cages, one at the edge of the AZE. Two reference stations are sampled outwith the proposed area (ideally 500 m – 1 km away).
Extended monitoring survey	Samples are taken along two transects, one running down current, one up current, with stations at the cage edge, 50 m and 100 m away in both directions. Two reference stations are sampled outwith the proposed area (ideally 500 m – 1 km away).
Site specific monitoring survey	Four stations are sampled along a transect, (direction of the transect is site specific), at the cage edge, 10 m inside the AZE, at the edge of the AZE, 10 m beyond the AZE. Two reference stations are sampled outwith the proposed area (ideally 500 m – 1 km away).

The timing of the sea bed monitoring is normally within 1 month of peak biomass, preferably between 1 May and 31 October except for the baseline monitoring which occurs before production begins. All sampling locations are recorded and fixed according to Differential Global Position Fixing or Range Position Fixing Systems, to ensure subsequent re-sampling of stations. All samples are taken using a Van Veen Grab, with a minimum sample of 0.02 m^2, with five replicates taken for biological analysis and two taken for chemical analysis. Sea bed monitoring of in-feed residues is carried out annually and if this coincides with the sea bed monitoring, then samples can be taken from the benthic replicates. In feed residue monitoring methodology is outlined in Table 19.

The methodology used in the sea bed monitoring sample analysis is summarised in Table 20 and the sediment quality criteria Table 21.

[55] www.sepa.org.uk/pdf/guidance/fish_farm_manual/annex/A.pdf

TABLE 19
In-feed residue monitoring strategy, United Kingdom

In-Feed residue	Timing	Location	Collection of samples	Analysis
Slice™[3]	Between 110 and 130 days after cessation of treatment	Samples taken from 2 stations on a transect following the current direction at the cage edge and 100m distant	Replicates of three sediment cores of up to 5cm depth. If coinciding with monitoring then sub samples of grabs are acceptable.	Samples analysed by accredited laboratory.
Calicide™[4]	Between 10 and 30 days after cessation of treatment.			

TABLE 20
Sea bed monitoring sample analysis, United Kingdom

Determinand	Methodology
Visual	Qualitative assessment. Colour: black brown, etc Consistency: sand, mud, etc Texture: soft, firm, etc. Presence of feed pellets and/or Beggiatoa
Redox	Two profiles are taken per sample at 1 cm intervals immediately on collection using a portable redox meter.
Organic Carbon	Samples are taken from 50ml of the top 2 cm of the sample. Procedure in Allen et al. (1974) is recommended for analysis.
Particle Size Analysis	Samples of 100 ml are taken from the top 20 cm and analysed by dry sieving or laser granulometry.
Benthic infauna	Grab samples are washed through a 1 mm sieve and preserved in buffered formalin. Fauna are identified to the lowest taxon possible and the data presented as a species abundance matrix e.g. Shannon-Weiner

TABLE 21
Sediment quality criteria and action levels* , United Kingdom

Component	Determinand	Action Level within AZE	Action level outside AZE
Benthos	Number of Taxa	Less than 2 polychaete taxa present	Must be at least 50% of reference station value
Benthos	Number of Taxa	Two or more replicates with no taxa present	
Benthos	Abundance	Organic enrichment polychaetes present in abnormally low densities.	Organic enrichment polychaetes must not exceed 200% of reference station value.
Benthos	Shannon-Weiner Diversity	N/A	Must be at least 60% of reference station value.
Benthos	Infaunal Trophic Index	N/A	Must be at least 50% of reference station value.
Sea Bed	*Beggiatoa*	N/A	Mats present
Sea bed	Feed pellets	Accumulations of pellets	Pellets present
Sediment	Teflubenzuron	10.0 mg/kg dry wt/5 cm core applied as a average in the AZE.	2.0 µg/kg dry wt/5 cm core
Sediment	Copper	*Probable effects* 270 mg/kg dry sediment; *Possible effects* 108 mg/kg dry sediment	34 mg/kg dry sediment
Sediment	Zinc	*Probable effects* 410 mg/kg dry sediment; *Possible effects* 270 mg/kg dry sediment	150 mg/kg dry sediment
Sediment	Free sulphide	4800mg kg^{-1} (dry wt)	3200 mg kg^{-1} (dry wt)
Sediment	Organic carbon	9%	
Sediment	Redox potential	Values lower than -150 mV (as a depth profile average) or values lower than -125 mV (in surface sediments 0 – 3 cm).	
Sediment	Loss on ignition	27%	

* www.sepa.org.uk/pdf/guidance/fish_farm_manual/annex/A.pdf

Self-regulation and voluntary monitoring

Currently the control and monitoring of sea lice does not fall under the remit of the regulatory authorities, but this will soon change with the implementation of the Aquaculture and Fisheries (Scotland) Bill (2006). The present arrangement is contained in The Code of Good Practice for Scottish Finfish Aquaculture[56], (CoGP), which specifies the 'National Strategy for the Control of Sea Lice on Scottish Salmon Farms'.

[56] www.scottishsalmon.co.uk/aboutus/codes.asp

Box 12 outlines the main actions included in the strategy. This strategy lays down the guiding principles and procedures to follow such as the formation of farm management areas, agreement on treatment criteria and strategic coordinated treatments within these areas. The CoGP is a voluntary code, drawn up by collaboration between industry, government, regulators and related stakeholders. Compliance is assured through certification and annual audits are performed and the audit results are to be made publicly available.

BOX 12

United Kingdom sea lice strategy

The National Sea Lice Strategy has developed a code of practice for salmon farmers, instructing on the following areas:

Defining the farm management area. See Annex 6 of the CoGP.

Identifying all the salmon farmers in the areas and obtaining written undertakings to observe the provisions of the Strategy. Each defined Management Area will have a farmer appointed as coordinator to aid cooperation and exchange of information between all farmers regarding sea lice control and treatments.

Forming a farm management group. Each area will have a farm management group. This group will agree the basis for sea lice monitoring and treatments, oversee and coordinate monitoring and treatment activities.

Agreeing the monitoring protocol and frequency of monitoring. Each area will have a regular monitoring procedure and the results will be communicated weekly to all farms in the area by the coordinator.

Agreeing the timing and criteria for treatments. Coordinated treatments will be carried out in early spring and early winter. The primary objective will be a target of zero adult female lice on farmed fish in the spring period when wild salmonids are migrating.

Carrying out the treatments. Treatments will be carried out promptly and in accordance with the principles of Integrated Sea Lice Management.

Performance review. Annual review meetings will be convened by farm management groups to evaluate the performance of farm in the areas. Auditing compliance will be carried out by independent UKAS accredited bodies, as part of the CoGP audit procedure.

The Scottish National Sea Lice Treatment Strategy has the following elements:

Lice numbers on all the farms in one area should be monitored regularly. The basis for the monitoring protocol is as follows:

- weekly monitoring is necessary throughout the year.
- cages and fish should be sampled at random.
- personnel carrying out lice counts should have appropriate training in lice recognition and recording and demonstrate post-training competence.
- where there are more than five cages per site, five fish should be sampled from each of five cages to give a total of 25 fish.
- where a site contains less than five cages, all cages should be sampled to give a total of 25 fish. A similar number of fish should be selected from each pen.
- minimum recording requirements during lice counts are *Lepeophtheirus salmonis* chalimus, non-gravid mobiles[57] and gravid females[58] plus *Caligus elongatus* mobiles.

[57] non egg-bearing louse (male or female)
[58] egg-bearing female louse

Farm management groups should aim to reduce as far as possible the risk of infection to wild juvenile salmonids. Suggested thresholds for the treatment of farmed salmon for *L. salmonis* are as follows:

- during the period February to June inclusive, coinciding with the appearance of wild juvenile salmonids in the sea, the criterion for treatment is an average of 0.5 adult female *L. salmonis* per fish.
- during the period July to January inclusive, the criterion for treatment is an average of 1.0 adult female *L. salmonis* per fish.
- treatment for episodic *C. elongatus* infestations should be applied, as appropriate, to protect the welfare of farmed fish.

UNITED STATES OF AMERICA

In the United States of America responsibility for carrying out environmental monitoring is found at State level. Two States are involved in salmon culture, Washington and Maine. The situation in the two States is described separately.

Washington State

In the State of Washington, the Department of Ecology is responsible for monitoring and compliance of salmon culture operations. The Recommended Interim Guidelines for the Management of Salmon Net-pen Culture in Puget Sound (Weston 1986) have been adopted as the basis of environmental assessment of salmon culture sites. The application of the guidelines is based on annual production, as follows:

- class I – up to 20,000 lbs (~9 tonnes) per year;
- class II – 20,000 – 100,000 lbs (~9 – ~45 tonnes) per year;
- class III – more than 100,000 lbs (~45 tonnes) per year.

These categories, in conjunction with current data, also form the basis for recommending minimum depth beneath salmon cages.

Three types of survey are described within the guidelines – a site characterisation survey, a baseline survey and annual monitoring (Weston, 1986). The following description of survey types is adapted form the SAIC interim Guidelines (Weston, 1986). Monitoring in Washington is largely carried out by consultants.

Site characterisation survey

This survey is performed prior to the permit application. It should provide the information necessary to enable State and local authorities to evaluate the potential effects of the environmental effects. It should provide the proponent with critical information in determining the site's suitability for the proposed project. Sediment chemistry and benthic infaunal information is not requested, as the precise net-pen location is unknown. The components of this survey are detailed in Table 3.4.1.

Baseline survey

A baseline aims to characterise the benthic conditions at salmon net-pen sites, prior to being altered by culturing activities. Ideally this survey should take place following the deployment of the cages, but prior to stocking. Class III operations require a baseline survey, whereas Class I and II operations do not. Details of the baseline survey are listed in Table 22.

Annual monitoring

The annual monitoring programme is designed to monitor potential changes in both water and sediment quality following the commencement of culturing operations. The collation of such data enables regular reviews on the annual monitoring programme. The elements of the annual monitoring programme are detailed in Table 22. Detail on the sampling protocol for each element is provided in Table 23.

TABLE 22
Details of components of the Site Characterisation Survey, Baseline survey and Annual Monitoring Survey as applied in Washington State, the United States of America

	Site Characterisation Survey	Baseline Survey	Annual Monitoring
Class I <20 000 lbs/yr, ~9 tonnes	• Consultation with State and local authorities • Bathymetric survey • Hydrographic survey • Current velocity and direction • Visual survey	N/A	N/A
Class II 20 000-100 000 lbs/yr, 9-45 tonnes	• Consultation with State and local authorities • Bathymetric survey • Hydrographic survey • Current velocity and direction • Visual survey	N/A	• Benthic Survey - Diver survey
Class III > 100 000 lbs/yr, ~45 tonnes	• Consultation with State and local authorities • Bathymetric survey • Hydrographic survey - Current velocity and direction - Drogue tracking - Vertical hydrographic profiling • Visual survey	• Sediment chemistry • Benthic infaunal sampling	• Benthic survey - Diver survey - Sediment chemistry - Benthic infauna sampling • Water quality sampling • Current velocity and direction

In addition to annual monitoring survey data and information, the annual report should contain a full description of site operations including:

- site configuration and details of any significant changes;
- production and stocking density;
- type of feed and feeding methods;
- details of antibiotic use;
- use of antifoulants;
- interactions with wild bird and marine mammals.

The survey work is carried out by professional biologists or consultants that are not employed by the farm company. Usually this involves biologists at the M.Sc. or Ph.D. level.

The methods employed in the surveys through the Interim Guidelines have not been formally assessed for practicality, cost effectiveness or scientific robustness. However, the methods represent "best professional judgment" and the guidelines have been widely reviewed by relevant agencies, NGO's and industry representatives.

State of Maine

A standard aquaculture lease application for a new salmon net pen facility requires a Environmental Baseline Field Survey to be carried out. The aim of this survey is to assess the existing environmental conditions prior to commencement of culture operations. More than one survey may be carried out by applicants but one of them must take place between 1 April and 15 November. Components of the Baseline Field Survey are detailed in Table 24.

Once culturing operations have commenced the farm operates under a MePDES permit (administered by the Department of Environmental Protection DEP, Maine State). This permit details the requirements for routine operational monitoring. All permitted facilities must 'conduct periodic monitoring of ambient water quality, benthic analysis, biological assessment and video/photo surveys. Two monitoring levels are defined (Table 25) based on location:

- **Level I** Those facilities located in the waters of Cobscook Bay, North or inland of West Quoddy Head in Lubec;
- **Level II** Those facilities located in waters between West Quoddy Head in the Lubec and Naskeag Point in Brooklin that are covered by this General Permit.

TABLE 23

Details of sampling protocol for environmental assessment of salmon aquaculture in Washington State, the United States of America, (SAIC guidelines, Weston 1986)

	Aim	Location and timing of sampling	Number of samples and replicates, where applicable	Analysis/ Notes
Bathymetric Surveys **SCS***	*To characterise the bathymetry of the proposed site (area within 300 ft of the cage perimeter)*			
Hydrographic Surveys **SCS and AM***	Current velocity and direction **AM**	Centre of cages – near surface (6 feet) and mid-depth	Measurements over 1 complete tidal cycle. Minimum of ten evenly spaced measurements at each depth. Mean current speed is determined as arithmetic average of the ten measurements	Not during spring or neap tides. During the report weather conditions should be noted. During **AM** single current measurement 20 ft down current of the cages
	Drogue tracking – *to estimate the potential fate of particulate material and the potential for eddy circulation*	2 drogues to be released from centre of site. One is set at 6 feet, one at mid-depth	Drogue trajectory should be followed for a minimum of 8 hrs	
	Vertical hydrographic profile – *to evaluate intensity of water stratification*	Centre of proposed site. Measurements should be made at 1, 10, 20, 30 and then 30 ft intervals to a maximum depth of 3 ft above sea floor		Where possible any existing information on the site should be provided
Diver/Visual Surveys **SCS and AM**	Applies to sites where the depth is under the cages or within 300 ft of the site is less than 75 ft. *To determine the presence of habitats of special significance (HAS).* *To estimate the extent of solid accumulation (**AM** only)*	**Site Characterisation Survey**		
		Exact location and number of transects should be established on consultation with State officials.	Where most of the area is less than 75 feet, 3-5 transects of 200 ft long	Surveys should establish details on substrate type, presence of Beggiatoa mats and presence/density of any HAS
		Annual Monitoring		
		4 transects, at least 200 ft long, starting from the centre of each side of the cage array.		Depth and extent of solid accumulation at 20 ft intervals along the transect. Presence and density of Beggiatoa mats and any HAS
Benthic Infauna **BS* and AM**		Stations should be established on a transect down current of the cages. Stations set at cage perimeter and at distances of 20, 50, 100 and 200 ft	Diver cores with area at least 0.01 m^2, or grab/box corer with area of at least 0.1 m^2. Samples should be sieved at 1.0 mm	All organisms should be identified to lowest taxonomic level, species where possible
Sediment Chemistry **BS and AM**		See location for benthic infauna	3 replicate diver cores, or 3 replicate grab samples	Analysis –TOC, T Kjeldahl N, particle size distribution. Eh discontinuity. Cores to 2 in.
Water Quality **AM**	*In order to document the effect of culture activity on dissolved oxygen and nutrient on the water column*	Should be conducted in July-September annually, within the hour of slack tide. 3 stations – 100 ft up current of cages, 20 ft and 100ft down current of cages	3 replicates at each station, at a depth midway between surface and bottom of cage nets	Analysis – dissolved oxygen, temperature, salinity, pH, ammonia, nitrite/nitrate, concentration of unionised ammonia. Loading estimates for ammonia and nitrite/ nitrate

* SCS – Site Characterisation Survey, BS – Baseline monitoring, AM – Annual Monitoring.

TABLE 24

Components of Environmental Baseline Field Survey as applied to new salmon facility applications in the State of Maine, United States of America

Component/objectives		Methodology/ equipment	Location and timing of sampling	Number of surveys/samples	Notes
Diver Survey – *to determine relative abundance of fauna/flora, sediment type and unique features of substrate*		Video camera preferred but still shots taken at 10 m intervals may be used. Remote video or stills camera to be used where the site is too deep for SCUBA	Video transect in direction of prevailing current, through the centre of the proposed site	Number of transects will be determined by DMR	The diver should document the flora and fauna and note relative abundance (abundant, common or rare)
Hydrography – *to measure current speed and direction and to predict the fate of waste feed and faecal material*		Subsurface current meter preferred but flow meters may be used with surface direction estimated	Current should be measured at 3 depths – surface, net pen bottom and 1 m above the sea floor. A 15-minute sample from each depth every hour for a period of 16 hours. An average tide should be used		
Water Quality – *to measure water temperature, salinity and dissolved oxygen during peak stratification*		Water samples may be taken, or an electronic membrane probe may be used. The preferred methodology for oxygen determination is 'Winkler Titration' but electronic membrane method is acceptable	Measurements should be made on two occasions, with one between 15 Aug and 15 Sept and should be over 2 tidal cycles. 1 profile should be taken within two hours of sunrise Detailed dissolved oxygen profile should be taken at the centre of the site (consisting of ten equally spaced samples over depth range). Temperature and salinity should also be measured		
Benthic Analysis – *to establish substrate reference data for future assessment of benthic impact*		A systematic sediment sampling plan should be prepared, which covers the proposed area of the site, plus 60 m in each tidal direction.	An array of single sediment core samples should be taken in order to fully characterise the substrate of the proposed site. Consultation with MDEP is recommended prior to implementation of the sampling plan		Samples to be used for sediment grain size and chemical and biological analysis
Infauna – *to establish reference data of existing benthic infauna prior to commencement of culture activities*		Samples to be sieved through 1.0 mm sieve. Benthic infauna cores used by diver should have area of at least 81 cm2. Cores may be collected from a grab or box corer and should have an area of 0.1 m^2.	Single core samples to be taken in accordance with proposed sediment sampling plan		Infauna to be identified to species or lowest taxonomic level. General characterisation of the community should be included.
Sediments	Sediment grain size	Wet sieving method described by Buchanan (1984)	Single core samples should be taken according to sediment sampling plan. The exact location for each core should be noted and reported.		Depth of core, unconsolidated organic material should be noted
	Redox discontinuity depth	To be measured from a plexiglas corer			
	Depth of unconsolidated organic matter	Determined by visual inspection			
	Total organic Carbon (TOC)	Unconsolidated matter and top 2 cm of inorganic sediment to be used. 30 g minimum sample. Methods: Puget Sound Estuary Program 1986			

The permit details two mixing zones at the facility as follows:

- **Water column mixing zone** defined as the entire area (from surface to water column/substrate interface) encompassing the net pen facility and extending out for 30 m from the perimeter of the cage array.
- **Sediment Mixing Zone** defined as the sea floor area directly under the area of the facility and extending out for 30 m from the perimeter of the cage array.

The permit states that beyond these allocated zones, farm operations shall not create conditions that may be harmful to aquatic life or any impairment to the receiving waters and its designated uses. Absolute allocation of mixing zones may be altered for individual sites. This is designed to reflect the effect of currents in that area, however, the area of the offset mixing zones must not be larger than that defined by the cage array.

The permit requires annual monitoring of ambient water quality within the Water Column Mixing Zone, at a far-field site (30 m down-stream of cages) at each group of cages, between 1 June and 31 October. Monitoring requirements are detailed in Table 25.

In some situations, two years of routine monitoring may show a facility to be in compliance with the regulatory standards, if this occurs the near-field (within 5 m of the cages) water quality monitoring frequency may then be reduced from two to one per month for Level I and from one per week to two per month for Level II.

In addition to water quality monitoring, each cage facility is required to carry out routine monitoring of the sediment and benthic infauna. Farmers are also required to carry out two video or stills photography (in colour) monitoring surveys per year, in April /May and in August. These surveys should provide an evaluation of the sea floor beneath and adjacent to each cage array. Requirements of the video surveys are detailed in Table 25 and consist of a series of 60 m transects. However the permit requires that multiple evaluations should be carried out where the size and layout of the cage arrays precludes coverage by one transect.

The MePDES requires that information on reference stations must be kept in order to provide comparative information on both water quality and benthic conditions. The DEP may require repeat or on-going reference monitoring in order to assess the results of the routine monitoring. The reference stations should be selected that best represent local ambient conditions and are not under the influence of culturing activities or other uses of the waterbody. The reference site should be at least 100 m away from the farm, in a direction perpendicular to that of the prevailing currents. A benthic reference station should be selected that has similar sediment characteristics to those at the farm site, if necessary one reference station per sediment type should be chosen. For each sediment type, three benthic samples are required at the reference stations.

The MEPDES permit has a number of Impact Thresholds[59] with respect to the sediment and benthic monitoring and video surveys. The DEP uses these thresholds to determine if discharges from the farm operations are causing impairment of the State's water quality criteria. There are a number of criteria for both within and beyond the sediment mixing zone. The details of these thresholds are provided in Table 26. The department requires that an operator must notify the DEP once any warning levels (see Table 26) for the Sediment Mixing Zone have been exceeded. The facility is then required to review operations and propose changes required to ensure that impact level is not exceeded. Where subsequent monitoring indicates that warning levels are further exceeded or that impact levels are exceeded, the facility must notify DEP and include a plan and implementation schedule for modification of operations at the site. The restocking of cages is prohibited until the plan is approved and implemented. Further monitoring may be required to determine the effectiveness of the measures.

[59] www.maine.gov/dep/blwq/docstand/aquaculture/MEG130000.pdf

Maine has three classes for marine and estuarine waters but there is little difference between the uses or the qualities of the various classes. All attain the minimum water quality standards for fishing and swimming established in the federal Clean Water Act. Most support the same set of designated uses with some modest variations in their description.

Class A waters allow impoundments and very restricted discharges, so the risk of degradation while quite small, does increase since there is some small human intervention in the maintenance of the ecosystem. Classes B and SB have fewer restrictions on activities but still maintain high water quality criteria. Finally, Classes C and SC have the least restrictions on use and the lowest water quality criteria. Classes C and SC waters are still good quality, but the margin for error before significant degradation might occur in these waters in the event of an additional stress being introduced (such as a spill or a drought) is the least[60].

Assessment of the impact of farm operations on the environment in Maine, particularly for semi-quantitative parameters, relies on comparison with data on the baseline conditions and reference stations. The methods employed have been assessed externally (on two occasions since 1987) for practicality, cost effectiveness and scientific robustness. The most recent version of the MePDES permit was developed through a public process and now contains a number of new parameters, such as redox and sulphide. These new parameters are currently being reviewed for efficacy. Contractors and consultants must possess appropriate certification from the State regulatory agencies. Agency staff can carry out random spot checks on how field monitoring is being conducted.

Field measurements may be carried out by farmers, consultants or regulators. Under the previous system operators paid a monitoring tax ($0.01 per pound harvested). This tax was paid to the State who then employed a third party to carry out most of the monitoring under the supervision of the State. 2003 saw the beginning of self-monitoring by the industry, where some monitoring is carried out by the company and some by contractors.

Modelling approaches

In Maine, modelling approaches are occasionally employed to identify potential problems and to design monitoring appropriate monitoring. At the present time, models are not used in enforcement or decision-making.

Ecological standards

Ecological Quality Standards have been set in Washington State for water (WAC 173-201) and benthos (WAC 173-204). The permit system in Maine (MePDES) defines a Warning and Impact Level system for a number of sediment parameters (see Table 26).

CONCLUSIONS

All of the countries studied have systems in place to monitor the effects that salmon farms have on the receiving environment. In general, the degree of monitoring in terms of frequency and or sampling amount or complexity is dependent on perceived risk, taking into account the scale of operations and the sensitivity of the receiving waterbody.

Benthos and sediments

Benthic effects are the easiest to detect and quantify and are therefore those that have received both the most academic study and regulatory attention. In general, the

[60] www.maine.gov/dep/blwq/docmonitoring/classification/

TABLE 25

Near-field, far-field and reference station water quality monitoring requirements, sediment and benthic monitoring and video survey requirements for the State of Maine finfish cage annual monitoring, Maine United States of America

Determinand	Location/Timing	Monitoring Level		Methods/Notes
		I	II	
Near Field water quality – at locations within 5 m down current of stocked cages, should represent maximum impact of operations.				
Dissolved oxygen concentration (DO) (mg/l)	(i) Samples to be taken at mid-netpen depth, mid-water column depth and 1 m above the sea floor for all parameters (ii) Samples to be taken within 1 hr of slack water before 0900hrs	2/mth	1/wk	If DO levels are below 6 mg/l in any of the samples additional samples should be taken.
Dissolved oxygen saturation (%)				If DO saturation is less than 85% in Class SB5 waters or less than 70% in Class SC waters, far-field monitoring shall be conducted
Salinity (‰)				
Temperature (˚C)				30 cm Secchi disk to be used and viewed using viewing scope. Average of depth at disappearance and reappearance.
Transparency (m)				
Far-field and reference station – samples to be taken at a position 30 m immediately down-current of stocked cages and at a reference station				
Dissolved oxygen concentration, DO (mg/l)	(i) Vertical profiles with parameters measured at intervals of 1m or less. (ii) Minimum, average and maximum value of each parameter to be reported (iii) Samples to be taken within 1 hr of slack water before 0900hrs	1/yr in Aug	2/yr - Aug and Sept	If DO saturation at the far field stations is less than 85% in Class SB waters or less than 70% in Class SC additional samples should be taken, samples should also be taken at reference station at comparable depth, time and tide.
Dissolved oxygen saturation (%)				
Salinity (in ‰)				
Temperature (˚ C)				30 cm Secchi disk to be used and viewed using viewing scope. Average of depth at disappearance and reappearance.
Transparency (m)				
Sediment and benthic monitoring – to be carried out at same time as video monitoring, along the same transect as described for video monitoring				
Redox potential (mV)	(i) Minimum of four stations along the transect – two on either side of the cage array (ii) One location 30 m away on either side of the cages, one location within the mixing zone (iii) At each location a minimum of three samples taken perpendicular to transect spaced at distances reflecting and within the lateral extent of greatest benthic impact (iv) If grab samples used for sediment analysis sub-samples, no more than ¼ should be removed	Apr-May and Aug-Oct		Cores of top 3 cm
Sulfide (uM)				
Anoxic sediment, gas formation and Beggiatoa				
Azoic conditions (per 0.1 square m)		1/5yrs in Aug/Oct as minimum		May also be required if warning levels are exceeded. . Single cores 4 inches or greater in diameter and inserted to resistance or 15 cm. Depth of core shall be reported. Samples sieved through 1.0 mm sieve. Taxa measurements to include presence, absolute and relative abundance and Shannon-Weiner Diversity Index
Infauna (per 0.1 square m)				
Sediment grain size (%)		When taxa measured		
TOC (mg/g)				
Copper – total metal (mg/kg dry wgt)		1/2yrs		Cores must be of top 2 cm. Should be measured when fish biomass is at maximum
Zinc – total metal (mg/kg dry wgt)				
Medications used (μg/kg dry wgt)		Within 1mth of use		Tests should include analysis for primary metabolites
Video (or photographic) monitoring				
Parameters: sediment type and colour, erosional or depositional areas, flora and fauna, presence of feed pellets, presence and appearance of Beggiatoa mats, presence of black sediments, out-gassing	Transect beneath cages: 60 m transect up-current from edge of cages; 60 m transect down-current from edge of cages	2 /yr		The department may waive the spring monitoring if the previous autumn survey indicates warning levels have not been exceeded. Beginning and end of each transect should be located by GPS. Images should provide 1 m^2 of sea floor coverage

TABLE 26
Sediment warning levels, Maine United States of America

Determinand	Sediment mixing zone (or within 30 m of cages)		Beyond sediment mixing zone (≥ 30 m from cages)
	Warning Level	Impact limit	Impact limit
Redox potential	Mean 100 – 0 mV nhe[6]	Mean < 100 mV nhe	Report level
Sulfide	Mean 1300-6 000 µM	Mean > 6 000 uM	Report level
Beggiatoa coverage	≥ 25 % photo coverage	≥ 50 % photo coverage	Compelling evidence[7]
Anoxic sediments	≥ 25 % photo coverage	≥ 50 % photo coverage	Compelling evidence
Pollution tolerant taxa	No. individuals in single taxa > 70 %	Report information	
Pollution sensitive taxa[8]	> 50 % reduction in mean abundance of taxa not identified as pollution tolerant[9]	Report information	SB waters – Significant reduction in mean number of listed taxa as compared to mean baseline or ref site SC waters – unsuitable for any species of indigenous fish, or structure and function of resident biological community is not maintained
Taxa richness	> 25 % reduction in total number of all taxa compared to mean baseline or reference site	Report information	SB waters – Significant reduction in mean number of total taxa as compared to mean baseline or ref site SC waters – unsuitable for any species of indigenous fish, or structure and function of resident biological community is not maintained
Azoic conditions	> 50 % reduction in total abundance compared to mean baseline or ref site	Absence of fauna	

methods used in Norway are designed to give quick and regular feedback but, for the higher frequency assessments, rely on relatively crude and subjective determinations. The annual macrofaunal survey, however, appears to be similar to that carried out in other countries so the overall level of environmental information should be good. Scottish sites are usually monitored every second year at peak biomass and the range of determinands studied is quite comprehensive. In particular there is a considerable emphasis on the measurement (and modelling) of in-feed sea lice medicines. In Ireland the Level 2 monitoring for medium sized sites consists of visual measurements and redox, which is a lower standard than in several other countries for similar sized sites. Large farms (>1 000 tonnes) require macrofaunal surveys (level 3). The benthic monitoring protocols in Chile, British Columbia (BC), Canada, and Washington State in the United States of America are broadly similar to those in Scotland, with both macrofaunal and biogeochemical determinands. This also applies to Maine, the United States of America, where Sediment Action Levels are clearly defined. Several countries have followed the EQS or Action Level approach, but there are a variety of different determinands so a comparison of standards is not possible. Nevertheless the approaches taken are very good and, if policing is adequate, are an extremely useful regulatory tool. An outlier is New Brunswick: this system relies heavily on sediment sulphide measurements as the key indicator of sediment condition.

In New Zealand, the situation is more complex as specific monitoring conditions are applied on a site by site basis but the suite of recommended determinands do appear to give very good environmental information. Modelling of benthic impacts takes place in most countries, particularly Scotland and Canada (BC), but at the moment only in Scotland is the modelling approach embedded in regulation.

Water column

Water column impacts generally refer to the release of nutrients and the reduction in ambient oxygen levels. As nutrient measurements require long time-series to be meaningful, several countries approach this by modelling e.g. Norway and Scotland. In most countries some measurements of oxygen profile with depth is required. While this may occasionally provide useful information, particularly if benthic oxygen demand is very strong and ambient currents are weak, occasional spot measurements of transient oxygen profiles are not likely to be particularly robust as indicators of impact.

Monitoring sea lice

Norway has lead the way on sea lice monitoring for many years with monitoring by State veterinarians and compulsory treatment trigger levels, although other countries, e.g. Scotland, are now taking this issue more seriously. Ireland and Canada also have regulations on lice burdens. There is still frustration that much of the data collected by farmers on lice is confidential and not available to public scrutiny. Similarly, data on medication frequency is not easily available.

Escapes

Escapes of farmed salmon are recognised to be a problem of particular importance when con-specifics are present and interbreeding may occur. Norway has recently taken a robust approach to regulation of escapes and assessing engineering standards of cage structures (NYTEK). In Scotland, reporting of escapes to the government is mandatory and in general farmers must have contingency plans for escapes. However, standards for containment across salmon growing countries are generally weak[61]

[61] www.worldwildlife.org/what/globalmarkets/fishing/

Assessing the effectiveness of the EIA and environmental monitoring process

The primary objective of EIA is an impartial assessment of the potential for environmental and societal costs and benefits of a development. Through a process of identifying the key hazards and mitigation, it should result in the consent of developments where there has been a transparent and systematic cost benefit analysis allowing development with net societal benefits within a policy framework. In this section we assess the technical appropriateness and effectiveness of the EIA and environmental monitoring processes, both regulatory and practical, in each of the countries using a variety of information sources both published and elicited through a questionnaire (Appendix 1). It must be stated that the rather poor response to the questionnaire has not made a robust assessment of stakeholder perceptions possible.

CANADA

In Canada, both federal and provincial government have responsibilities for aquaculture activities. At the provincial level a number of agencies may be involved in site approval, production licensing and environmental monitoring. There is recognition that greater harmonisation is required between regional and federal government in terms of aquaculture governance. At present the National Aquaculture Framework Agreement is pending and should provide consistency in policy across Canada.

In general most regulator and industry representatives agree that optimum measurements are being taken to protect the environment. Some scientists, however, would like to see a wider range of measurements and effects taken into account as part of the EIA process.

Feedback Mechanisms

Industry representatives believe that environmental monitoring has confirmed that well located farms have good environmental performance and that it does contribute to improved site selection. However, optimum production levels are often only determined by trial and error. It has been suggested that accelerated monitoring, perhaps three or four times per year, could be useful in determining if management practices are effective and if production levels are appropriate. Harmonisation of the governance (within provinces and with federal government) of aquaculture should serve to improve the effectiveness of feedback mechanisms in improving site selection and farm development.

Mitigation Measures

In British Columbia a maximum allowable chemical standards is set, which farms must not exceed at peak production. When these standards are exceeded the farm is not allowed to re-stock until levels return to below the allowable level. In some occasions this has resulted in extensive operational adjustments in order for site operators to ensure that they remain below the allowable levels.

In New Brunswick, a mitigation and remediation process is built in to the Environmental Monitoring Program. The process is based on compliance with the MEQO set for finfish aquaculture sites – sediment sulphide concentration - and is described above. Remediation Plans are drawn up for sites that receive a poor rating during the annual monitoring programme. A number of recommendations may be made as part of such plans, these include, but are not limited to:

- increased environmental monitoring;
- changes to site management and operations;
- review of harvesting strategies;
- retraining of site staff.

Implementation of such plans has been relatively successful and resulted in improvements to benthic conditions in many cases.

Stakeholder perceptions

In general, industry representatives consider that all reasonable steps are currently being taken in order to assess the environmental impact of aquaculture activities. Many companies feel they abide closely with environmental regulations in order to protect the environment they work in. However, some variation in commitment to environmental ethics does exist across the industry sector. There is also a concern that the current process largely serves to restrict aquaculture expansion, rather than to improve management practices.

CHILE

The approach applied in the EIA process in Chile is technically appropriate and Resolution 404/2003 provides a detailed description on the methodologies to be used. In 2005 the OECD reported that the "EIA system is well established and has proved active and influential" (OECD 2005). The main issue with the system at present is that the regulatory authorities lack adequate financial and staff resources to ensure full and effective enforcements of the system (OECD, 2005; Leon, 2006). There is a feeling that the process of environmental monitoring of salmon farm impacts requires more effective data and information collection. This could help inform and improve the management of sites.

Feedback mechanisms

Feedback mechanisms (when the regulatory system is effective) appear to be working within the system. Within the Chilean salmon industry there are examples where sites that show poor environmental performance have switched to less intensive species (i.e. shellfish species), while salmon farms are moving into deeper sites with greater current speeds. There has also been a trend for salmon farms that are in environmentally good sites to increase capacity.

Mitigation measures

Within the Environmental monitoring system there is a mandatory mitigation strategy based on the presence of anaerobic sediments within the farm site area. Where anaerobic conditions are detected two years consecutively production capacity must be reduced by 30 percent. These measures will be applied annually until aerobic conditions are restored (RAMA, 2001). Some stakeholders are of the opinion that the level of accomplishment of the system is low and there is little information on how successful the measures are.

Regular reviews

RAMA (Environmental Regulation on Aquaculture) was initiated in 2001 and was under revision in 2006. The methodologies applied to Preliminary Site Descriptions and Environmental Information as detailed by Resolution 404/2003 are reviewed every two years.

Stakeholder Perceptions

The general perception is that the current regulatory system has the potential to be an effective tool. However, the enforcement of the system is hampered by the lack of financial resources and adequately trained staff. This has been of particular concern to the public and the scientific community (Leon, 2006). The system also lacks an auditing system, which would improve the confidence in the system.

IRELAND

The Marine Institute, created under the 1991 Marine Institute Act, a section of DCMNR, is the national agency that primarily carries out the environmental monitoring associated with salmon farming. As the DCMNR also issues and enforces the licensing system there are direct linkages between licence requirements and environmental monitoring and implementation. The statutory monitoring of sea lice levels and benthic impacts of salmon farming is collected and analysed by the Marine Institute and the results are given to the farm usually between 5–10 days after the inspection. The monitoring programme is based on that implemented by SEPA in Scotland, where it has evolved through application at a large number of sites. The level and frequency of the monitoring programme to be applied to each site is assigned on a case-by-case basis, commensurate with the particular conditions at the site location. This means that the monitoring programme is tailored to each site.

Water column monitoring has been carried out on salmon farms since the 1980's. A review of the water quality data collected between 1985 and 1997 indicated that there was no detectable change in the levels of inorganic nutrients and it was proposed that water column sampling would be conducted only in the winter months (McMahon, 2000). This is consistent with the operation of salmon farming in Ireland. Irish farms tend to be located in areas of high flushing rates, resulting in rapid dispersion of dissolved substances, with half of all salmon farms licensed to produce less than 500 tonnes, i.e. relatively small by global industry standards.

Benthic monitoring results are compiled into an annual report submitted to the DCMNR. Should this highlight unacceptable impacts, the farmer must implement a Benthic Amelioration Plan. This plan addresses the impact by including at least one of the following:

- moving cages away from the area of impact to another location within the licensed area;
- reduction in tonnage at the site;
- use a different feed formulation to reduce the feed conversion ratio.

The implementation of this plan reduces the level of impact and allows the recovery of the benthic environment.

The sea lice management strategy has five principal components:

- separation of generations;
- annual fallowing of sites;
- early harvest of two-sea-winter fish;
- targeted treatment regimes, including synchronous treatments;
- agreed husbandry practices.

Together, these components work to reduce the development of sea lice infestations and ensure their most effective treatment. The separation of generations and annual fallowing prevent the vertical transmission of infestations from one generation of fish to another. The early harvest of two-sea-winter fish removes a potential reservoir of lice and the complimentary husbandry and synchronous treatments enhance the efficacy of treatment regimes. The setting of treatment triggers is integral to the effectiveness of this approach. Over the period since the initiation of a Single Bay Management (SBM) in 1998, treatment trigger levels have progressively reduced from an initial starting point of two ovigerous females to the current 0.3–0.5 ovigerous females per fish. This is an indication of the effectiveness and appropriateness of the strategy.

Effective mitigation

The Irish approach to mitigating the environmental impacts of established salmon farms is based on a positive feedback system stemming from the monitoring programmes e.g. triggering treatments or requiring the implementation of Benthic Amelioration Plans.

Regular reviews

The environmental monitoring system operating in Ireland is under constant review, with one of the more recent initiatives informing on incorporating the approach of Integrated Coastal Zone Management, (CLAMS). The complete regulatory approach and methodology applied is currently undergoing review.

NEW ZEALAND

The Australian and New Zealand Environment Conservation Council (ANZECC) published the revised Australian and New Zealand guidelines for fresh and marine water quality in 2000[62]. These guidelines provide the basis on which all environmental monitoring is conducted in relation to salmon farming in New Zealand. The core concept of these guidelines is identifying "environmental values", which are determined by the local community and regional councils. These values are further defined by Water Quality Objectives, specific to the aquatic environment in that region. Determinands are then selected and trigger values assigned to each to assess the impact of the activity and whether action is required. These guidelines are extensive and to aid use 'Guideline Packages' are provided for common issues such as HABs. For salmon farming a package relating to maintaining aquatic ecosystems would include water quality objectives for nutrients and decreased levels of dissolved oxygen. For each objective, determinands are listed (e.g. total phosphorus, total nitrogen, chlorophyll a, dissolved oxygen) and assigned a trigger value. This trigger value may either be a threshold level or an acceptable range of values. Alternatives to trigger values are also given for more complex water quality issues, for example a whole waterbody may be assigned a target load for nutrients.

Effective mitigation

The environmental regulatory and impact management system in New Zealand is based on a comprehensive array of EQS's, site specific "Water Quality Objectives" all with trigger values, that are either a single threshold or a range of values that once exceeded remedial action is required. This foundation should ensure a focused mitigation regime. The allocation of areas specifically for salmon farming contains most impacts into discreet regions. When conditions exceed the EQS the salmon cages are moved to a pre-assigned refuge area, within the AMA until the conditions return to acceptable levels. As this process adds another layer of managerial complexity, and as conditions at the refuge site are usually sub-optimal for the farmer, there is an inherent incentive to maintain the EQS's at the farm site. In developing a system whereby salmon farming is restricted to a defined area, (they cannot simply move away and establish a new site when EQS's are exceeded, as in Norway), the farmer is forced to operate within the capacity of the AMA.

[62] www.deh.gov.au/water/quality/nwqms

Regular reviews

The current system is under constant scrutiny, having been completely reviewed in 2004. The level of detail and timescale is at the discretion of the regional councils and will be stipulated in their Regional Coastal Plans.

Stakeholder Perceptions

The previous system in operation was perceived to be so complex and slow that it was restricting the expansion and productivity of the industry unnecessarily. High demand for space for aquaculture in some parts of the country and the demands placed on statutory bodies in terms of expertise for auditing environmental impact assessments led to a backlog of applications for marine farming permits. This, and the precautionary approach to assessment of environmental effects where information was inadequate, was perceived as compromising the development of the industry. Furthermore, the two-permit system led to situations in which applicants who had gone to the expense of conducting an assessment of environmental effects, and been granted a coastal permit, found their applications for marine farming permits subsequently rejected by the Ministry of Fisheries because of conflict with fisheries interests. As the current system is still in its infancy stakeholders are applying a ‘wait and see’ approach before commenting.

NORWAY

The main focus of environmental monitoring and EIA is directed at evaluating the effects of organic waste on the benthic environment.

The MOM monitoring programme on which NS9410 is based was tested and validated in over 200 investigations in Norway. This has ensured that the process is robust, fit for purpose and cost effective. The sampling methodology for the B investigation is designed so that all samples may be collected in a small open boat in rough weather conditions. A big advantage is that determinands can be quantified immediately and the results given to the farmer on the same day - determinands that require laboratory analysis are excluded. However, by omitting determinands that require more than one day’s analysis, this level runs the risk of using subjective or imprecise measurements, although using determinands in concert will make the results robust and by taking many samples the final determination of the environmental condition increases in reliability.

The C-investigation is a more complex investigation and its main purpose is to monitor the long-term changes in the sediment along a transect running from the local through intermediate to regional zones. Environmental impacts in the intermediate and regional zones are less tolerated than those in the local zone. The benthic macrofaunal determinands included in this investigation are sensitive enough to detect subtle impacts and are based on established ecology of organically enriched sediments (Pearson and Rosenberg, 1978; Pearson, Gray and Johannessen, 1983; Gray, 1992; Hansen *et al*, 2001). It is performed according to NS9423, the Norwegian Standard for sampling and investigation of benthic infauna and NS9410. The sampling frequency is set by the County Governor Department of Environmental Affairs.

At all fish farms prevalence data for sea lice must be recorded at least every second week when the water temperature exceeds 4°C and the results are reported to the Norwegian Food Safety Authority. If the number of lice per fish exceeds the threshold limits the fish farmer is required to delouse at the farm.

Feedback mechanisms

The B investigation gives an instantaneous result on the sea bed conditions in the vicinity of and under the farm. The results from the three sets of variables are combined and the degree of exploitation of the site is determined in accordance with the set EQS’s.

Should the Environmental Condition (EC) of the site be considered 'unacceptable' the farmer can immediately set in place management practices to reduce the environmental impact and return the site to an "acceptable" EC.

Effective mitigation

When "unacceptable" environment conditions are found the usual method of mitigating the impact has been to abandon the site and relocate to a different area. Increasingly this has meant that farms are moving into more exposed areas with greater flushing rates, which minimises the impact of the organic loading and so reduces the benthic impact. However by moving cages that were not designed to withstand the exposed conditions the number of farmed fish escaping escalated. This created a situation where the farmed fish were in direct contact with wild stocks leading to increasing levels of genetic impacts. The NYTEK regulations were developed as a direct response to mitigate against these impacts. However, as they are not due to be fully implemented until 2008 the effectiveness of these regulations cannot be ascertained. Alternatives to relocating are lowering production levels or fallowing sites and this is now the norm.

Regular reviews

All Norwegian standards are reviewed every five years.

Stakeholder perceptions

Stakeholders perceive the EIA process as a means of showing that they are complying with environmental regulations and managing the industry to minimise negative impacts generated from farming activities. However, the farmer's interest in environmental impacts is usually restricted to the immediate location of the farm site.

UNITED KINGDOM

Environmental monitoring

SEPA is the competent authority for regulating pollution originating from salmon farms, duties assigned to it under the Environment Act 1995, the Control of Pollution Act (CoPA) 1974 and the CAR regulations which have replaced CoPA. It also has special responsibilities designated under the Birds and Habitats directives. This requires SEPA to take a long-term, holistic approach to the protection of the environment and associated monitoring, (Henderson and Davies, 2000). Before a "Consent to Discharge" is granted Scottish Natural Heritage (SNH) is consulted, so including a nature conservation remit into the process. In granting a "Consent to Discharge", SEPA set out conditions and restrictions on the salmon farm which control the amount of wastes and chemicals entering the receiving environment. These conditions are set on a site-specific basis, based on expert judgement and well-established science. EQS's are set for all determinands and environmental monitoring regimes are devised to promote Best Environmental Practice (BEP), considering water column, sediment and biological characteristics. This holistic, site-specific approach ensures the technical appropriateness of the monitoring regime as it is tailored for the particular sensitivities of individual sites. Consent conditions are based on the carrying capacity of the site location, aiming to balance fish biomass with associated environmental impacts. Carrying capacity is assessed on site characteristics; existing environmental stress, dispersion and flushing patterns, previous management history and any conservation designations (*e.g.* Special Areas of Conservation). Deposition models (autoDEPOMOD and DEPOMOD, Cromey *et al.*, 2002a, 2002b) are used to assist in predicting the level of impacts and carrying capacity. Models are also used to control chemicals and therapeutants, using short and long term dispersion models on a case by case basis.

Sea lice monitoring

Until the Aquaculture and Fisheries (Scotland) Bill (2006) is implemented, sea lice monitoring continues under the regime as detailed in the CoGP. This code was developed with input from industry, regulators, government and related stakeholders and is based on defining discrete management areas, Area Management Agreements are developed to address the specific needs of each area. These areas are defined according to farmers experience and local knowledge, as hydrodynamic models, capable of predicting dispersion of fish disease and parasites, are poorly developed. A tidal excursion model was established by Fisheries Research Services (FRS) in 1998 to manage the outbreak of infectious salmon anaemia. However this model produced management areas that were too large to apply a single management plan to and a pragmatic approach lead to the proposed units being further divided. However the National Sea Lice Strategy has been drawn up under the Tripartite Working Group concordat[63] with farmers working alongside wild fishery interests such as the Association of Fishery Boards, which ensures the resultant Area Management Agreements are appropriate and fit for purpose. Monitoring occurs weekly, carried out by trained farm staff with regular visits by Fishery Board staff. The monitoring results are communicated within seven days of sampling to all farms in the management area and this information directly influences the future management regimes of the farms. This feedback system ensures that a rapid response can be taken in the event of the lice level criteria being exceeded.

Effective mitigation

Setting a cap on the biomass permitted on each site, on the basis of the assimilative capacity of the environment, constrains the environmental impacts from the outset. The main regulatory body, SEPA, applies the precautionary approach to environmental monitoring and the setting of EQSs. In general, impacts have been proven to be of a transient nature. The frequent monitoring of sea lice levels and rapid turnaround of results means the sea lice strategy can be effective in managing lice levels on farmed fish. Non-participation by some farmers has now been addressed with the Aquaculture and Fisheries (Scotland) Bill (2006), which establishes statutory monitoring and management procedures in relation to lice levels on farms.

Regular reviews

The complete regulatory framework is routinely reviewed by SEPA involving external academic consultants. Employing an iterative system ensures that the consent conditions set are appropriate. Responsibility for conducting these reviews lies with the Aquaculture Project Management Group who co-ordinate with the Scottish Government in reviewing how the industry is regulated. The sea lice monitoring strategy has just undergone a comprehensive review resulting in the Aquaculture and Fisheries (Scotland) Bill (2006) which was subject to public consultation at an early stage of drafting.

Stakeholder perceptions

Industry views the current regulatory regime as too precautionary and unnecessarily complex. The high degree of regulation in comparison with competing countries such as Norway and Chile, and the financial burden this places on salmon farm companies, may make Scotland less competitive in the global marketplace.

UNITED STATES OF AMERICA

In general, there is agreement between industry, regulators and researchers that the optimum measures are being taken to protect the environment. Some aspects of the

[63] www.scotland.gov.uk/Topics/Fisheries/Fish-Shellfish/18677/14726

process are viewed to be less effective (such as Washington State's sediment TOC program). In Washington, the Department of Natural Resources has the opportunity, through the leasing process, to add additional monitoring measures (through its Plan of Operations) to the lease requirements as set by the regulatory agencies.

The regulatory agencies (DEP) in the State of Maine feel that much of the current monitoring requirements (the most recent MePDES permit system, initiated in 2003) are excessive and often unnecessary. The system is very bureaucratic, which results in slower response times. The new system has also seen the previous cooperative nature between industry and regulators replaced with legal defensiveness. There is a feeling that under the new permit the environment may, in some ways, be worse off since farmers are more reluctant to learn new techniques to improve efficiency and lessen environmental impact. Monitoring could be more strategically targeted, as it was under the pre-2003 system, while providing the same level of environmental protection.

Feedback mechanisms

In the United States of America there are good feedback mechanisms that can inform better site selection and aquaculture performance. Interaction largely occurs between the state regulators and companies involved with professional biologists. The system is designed to identify the sites that are unlikely to meet environmental standards at an early stage. This way site configuration and management can be optimised to help achieve the necessary standards. In some cases application of up-to-date husbandry and technology approaches has meant that marginal sites can increase capacity.

Mitigation measures

In some cases, such as prevention of escapes and reduction of metal contamination, there have been effective mitigation measures to reduce impact on the environment. Other mitigation may involve site abandonment, where a farm is found to be grossly out of compliance. However, mitigation may also simply involve monitoring of the impact. Measures that may be recommended include site reconfiguration, reduction of load through improved feed loss rates, net cleaning and fallowing.

Regular reviews to legal requirements for EIA

In Washington State, legal requirements for EIAs (through the NPDES scheme), monitoring practices and procedures are reviewed every five years. In Maine, the legal requirements are reviewed periodically. Three reviews (two external) have been carried out since 1987 and another is scheduled for 2008.

Stakeholder perceptions

The EIA process is often conducted at both the federal level and the State level. The industry regards the EIA and monitoring processes as fair and rigorous, but they are considered to be very costly and time consuming. Large companies may have to employ several people that are dedicated to the environmental monitoring of their sites. To this end many industry representatives feel that the process is not efficient. The industry also views much of the process as a paper filing exercise with few tangible benefits. There is also a feeling that mitigation measures are often not implemented.

CONCLUSIONS

In the initial period of development of the salmon industry, site selection was often ad hoc with few environmental considerations and relatively undeveloped regulatory machinery, competence and resources. It is clear from the above analysis that in all salmon-growing countries there are now well-developed regulations and sufficient regulatory competence and resources to implement these. The exception may be Chile where while the regulatory framework appears sound, the practical application of these regulations in a very quickly expanding industry may require greater resources. However, between all countries, including Chile, there is a regular cross-comparison of standards and regulatory techniques, often through staff transfers or academic visits, and this should be further encouraged so that industry and regulators can compare concepts and practices and adopt the best after-adaptation to local environmental conditions.

Improvements to the EIA and environmental monitoring process

The EIA and environmental monitoring approaches followed in each country have strengths and weakness in meeting their objectives. In this section we attempt to identify any constraints relating to technical/scientific, financial, social and legal issues involved in the EIA process and suggest improvements that may be applied to these areas for each country. A synthesis table (Table 27), has been complied to highlight the varying approaches taken.

CANADA

There is recognition within the Canadian aquaculture sector that there is a lack of harmonisation between federal and regional roles in regulating aquaculture activities. A National Aquaculture Framework Agreement is expected to alleviate some of these issues and may help to reduce duplication of effort in some areas. The major constraints within the industry are the cost and time implication of EIA's and routine monitoring.

Better communication between industry and NGO's, with a focus on common issues, such as improving the sustainability and transparency of the industry, is desirable. The industry feels that, ideally, poorly performing sites should be relocated to more appropriate locations. This should result in a reduction of environmental impacts. However, this process is often hampered by NGO involvement. Aquaculture is not widely supported as a method of food production in Canada. This could be improved by a combination of greater industry transparency, better political support and improved public education.

On the research side there is a need to focus and better coordinate research efforts in order to prioritise and develop the needs of the industry and for improved sustainability. There is a lack of appropriately qualified scientific personnel, particularly in the area of benthic ecology and this is regarded as a major issue for the EIA and environmental monitoring processes in Canada. At present, in British Columbia, there are only a handful of well-known invertebrate taxonomists that are able to process and analyse benthic samples. Staff and resources are also an issue at government agency level, particularly as the industry is growing rapidly. Targeted capacity building is required at the university and research level. This should facilitate the scientific needs for the industry as well as providing much needed personnel.

Currently there is a reliance on chemical standards in EIA's and environmental monitoring. There is a need for biological standards within both processes. Far field affects are given little consideration at present. Current research in this field needs to be evaluated and appropriate guidelines and standards need to be incorporated into the regulations where applicable.

Collation of relevant environmental data can be costly and time-consuming and this is a major constraint for the industry. Such constraints are likely to increase substantially as the salmon industry is moved offshore into deeper waters (from 40-80 m to 200 m plus). Traditionally, equipment, such as grabs, are easily deployed from small or medium sized vessels. As the industry moves into deeper water such operations may become technically more difficult, as well as more costly.

More frequent monitoring has been suggested, particularly in the New Brunswick area, as a more efficient method of gaining information on farm's environmental performance.

This is particularly relevant for farms that consistently perform badly and should facilitate quicker implementation of remedial action and thus reduce environmental impact.

CHILE

In 2005 the "Environmental Performance Review of Chile" was published on behalf of the Organisation for Economic Cooperation and Development (OECD) and the Economic Commission for Latin America and the Caribbean (ECLAC) (OECD, 2005). A number of recommendations were put forward for salmon farming including:

- strengthen enforcement capacity of the relevant agencies;
- adoption of "polluter pays" principle in accordance with the FLE;
- adopt an integrated management plan for coastal areas;
- improve environmental and health management of salmon farming.

Several of these recommendations mirror the concerns of both the general public and the scientific community within Chile, particularly in regard to the enforcement of environmental regulations. There is a belief that within the enforcement agencies there is a lack or resources, in terms of adequately trained staff and technology. This has resulted in limited effective enforcement and monitoring. Training is also lacking for farm personnel. Chile has adequate laws and detailed methodologies to monitor and protect the environment, but additional resources are required to fully implement the regulations (Leon, 2006). There is also a need for improved monitoring and auditing of the current system. Improved skills base is required for regulatory agency personnel in order to improve analysis and interpretation of monitoring results.

Greater awareness of the potential impacts of salmon culture is required on the part of the industry. In addition, the current regulatory system does not take account of other potential impacts, such as, far-field environmental impacts, sanitary conditions and implications and impacts on sea mammals. There is inflexibility in the current legal system and regulations should be modified to take account of other impacts. Some stakeholders feel that the regulatory tools need to be strengthened in order to have a greater influence on the future development of aquaculture.

IRELAND

Salmon farms in Ireland are located along the west coast of the country, in highly flushed sites and are generally of a small size in comparison to other countries. The expansion of the industry is restricted more by outbreaks of disease and a lack of suitable sites than by environmental constraints. Ireland has not applied a "carrying capacity" approach in its policy regarding siting of salmon farms and the EIA process does not adequately consider the cumulative impacts caused by several farms in close proximity (Porter, 2005). Adding the element of "carrying capacity" to the regulation of the Irish industry would link the production of the farm with the sensitivity of the receiving environment and so improving the effectiveness of the monitoring regimes. Due to the shortage of suitable locations for farming operations there is a growing pressure to develop offshore sites. However there are no regulations regarding installation requirements, such as the Norwegian NYTEK regulations, which may mean cages of inadequate standard are placed in high energy sites, which may result in increasing levels of escapes.

NEW ZEALAND

The environmental management of salmon farming in New Zealand has been substantially revised and rationalised through the Resource Management Act (1991) and more recently, the Aquaculture Reform Act (2004). The implementation of the controls in this new approach led to a moratorium on new farms between November 2001 and December 2004, to allow regional councils to establish the necessary infrastructure to carry out the amendments and designate Aquaculture Management Areas. As this approach is so recent, no improvements have yet been identified but these may become apparent in time.

NORWAY

The benthic impacts of salmon farms have been addressed by NS9410, the MOM system and relocation of cages. However, the MOM system does not address the genetic impacts of escaped farmed fish, parasite and/or disease transference to wild stocks and the impacts of chemicals and anti-foulant compounds.

A model for dispersion of sea lice has been developed but needs further validation and the NYTEK regulations are the first step Norway has taken to reduce the number of escaping fish by establishing basic requirements for cage structure.

Environmental monitoring has emphasis on local, small-scale measurements which up till now has covered the most important impacts. Today fish farms are seldom allowed to relocate due to unacceptable benthic conditions; other mitigating methods such as reducing the production or changing the position of the farm within the site are used. However, the cumulative impacts of salmon farming on regional basis need to be addressed, both with regard to benthic and pelagic effects as the level of production continues to grow annually by 6–10 percent. A model for predicting regional phytoplankton concentrations has been developed (NORWECOM) but needs further validation.

UNITED KINGDOM

Some of the models used to predict impacts are untested/validated for high-energy sites and in these cases SEPA have set an arbitrary upper limit for site biomass:

> *In particular, in view of the potential to under-estimate impacts, there is a significant degree of uncertainty associated with very large production units and SEPA has therefore adopted an upper size limit of 2 500 tonnes biomass until it has more confidence in model predictions at this level of production.*[64]

This precautionary limit will likely be revised when the appropriate model validation or other research is carried out, as there is a continuing demand from industry for larger sites with their economies of scale.

In order to improve the understanding of both nutrient flows and disease organisms in Scottish waters, significant improvements are required in hydrodynamic modelling in order to improve regulation of assimilative capacity and disease transmission between wild and farmed, and farmed and farmed stocks.

UNITED STATES OF AMERICA

Public perception of the aquaculture industry in the United States of America is an issue. Aquaculture as a method of food production is seen as being unsustainable. This view is partly cultivated by NGOs. Communication levels, both within the sector and to other interested parties (NGOs and general public) needs to be improved through reduction in mutual distrust: public understanding of the industry's environmental and social costs and benefits is a significant block on the rational development of the industry. A system that encourages all stakeholders to contribute to solving the industry's problems and constraints is required. Engaging stakeholders is more likely to produce beneficial outcomes than litigation.

The cost of monitoring and permitting is excessive in the United States of America, particularly for small operators. The system has effectively meant that only large

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[64] www.sepa.org.uk/pdf/guidance/fish_farm_manual/main/5.pdf

companies can operate, as they often have to employ dedicated staff to deal with monitoring and permitting regulatory requirements. In Maine there are currently no small operators and the industry has consolidated.

In the State of Maine, the industry fears that monitoring findings will be misused or inappropriately applied by the regulatory system before validation has taken place. Operators are now reluctant to monitor anything other than the legal minimum. The financial and regulatory burden of the current system has reduced the ability of the industry and the regulatory agencies to invest in essential research and development. It is believed that some of the environmental permit conditions could be relaxed, without reducing the protection to the environment, but may help to improve the ability to invest in experimentation. A more efficient system could be gained from a more strategic approach to monitoring.

In Washington State, there has been no recent expansion in the industry, largely because of opposition from NGO's, other developers and the public. Similar comments relating to industry stakeholder engagement to those made for the State of Maine are also relevant here.

SUMMARY

A general weakness across countries is the focus on individual sites sometimes at the expense of consideration of cumulative impacts at the regional scale. In order for such considerations to be effective there is a general need for improved modelling and long term data sets against which to test these models. These are generally expensive and require vision as their benefits are necessarily only realized after many years owing to typically high levels of inter-annual variability in coastal ecosystems.

Embedding aquaculture in a coherent system of integrated coastal zone management (ICZM) is an oft-repeated aspiration, but progress is inevitably slow owing to the multi-sectoral approach in most legislatures. Allocation of space to salmon farming and then allocating that space to individual companies presents problems and is especially difficult when there is already pressure for expansion or enlargement of the industry.

A common thread amongst countries is the desire (or policy) of encouraging salmon farming to move from sheltered coastal inlets to more exposed coastal sites – often termed "offshore" but not to be confused with truly offshore development, perhaps out of sight of land. However, the risks of such policies must be better analysed as the typically harder habitats encountered may in fact be highly sensitive to fish farm wastes (Hall-Spencer *et al*., 2006). The following text is condensed from the abstract of that paper:

> Atlantic salmon (*Salmo salar)* cages are being moved out of areas with slow water movements, to disperse wastes and reduce impacts on benthic communities. This first study of the effects of fish farms on maerl beds, (red algal coralline gravels of high conservation importance) demonstrated major impacts on the benthos even in strongly tidal areas. SCUBA surveys of three fish farms located over maerl revealed a build-up of waste organic matter and 10 to 100-fold higher abundances of scavenging fauna than on six reference maerl beds. Visible waste was noted up to 100 m from cage edges and all three farms caused significant reductions in live maerl cover, upon which this habitat depends. Relocation of fish farms to areas with strong currents is unlikely to prevent detrimental effects to the structure and organization of the benthos and "fallowing", (whereby sites are left unstocked for a period of time to allow benthic recovery), is inadvisable where slow-growing biogenic habitats such as maerl are concerned, as this may expand the area impacted.

Also, placing cages in ever more exposed areas has created a situation where escaping fish are considered as the most detrimental impact, with benthic and water column impacts of lesser importance, but most environmental monitoring practices are still largely based on assessing benthic impacts. In all the countries studied (except New Zealand) there was pressure for the industry to relocate to offshore sites. To address this situation a review of regulatory priorities, informed by new research, needs to be undertaken to determine the potential environmental impacts and to identify appropriate indicators and procedures.

Clearly, regulations need to be developed that better understand the impacts of salmon farming in highly dispersive areas and hard substratum sea bed habitats.

There is some concern regarding the Quality Assurance of the various monitoring regimes – in order for the public to have confidence in the environmental performance of the industry, it is vital that all stages of the regulatory process are transparent and robustly documented.

Ultimately, links between regulators and the industry must be strong, as both have common interests: regulators have statutory obligations to protect the environment but also to consent legitimate development that brings socio-economic benefit; the industry needs both a clean environment and to ensure good public perception of environmental standards in order to sell its product. As regulators must act against serious infringements, and when this happens the infringement generally becomes public knowledge – damaging the whole sector – it is in the industry's best interest to protect itself against farmers with poor environmental standards. This has given impetus to the development of industry associations with Codes of Practice that can require members to achieve standards higher than the statutory minimum. Such schemes can only gain public confidence if they are seen to be independently audited with public reporting. The Scottish Salmon Producers Association is currently implementing such a scheme and it is likely that similar associations in other countries will be closely monitoring the success of this.

Little information was found regarding a regulatory approach to the proportion of wild fish derived feed in salmon diets – indeed this aspect is generally missing from the EIA process despite it having a high environmental cost and being the subject of public concern. As salmon account for a considerable share of fish meal/oil it might be appropriate for regulations to be developed on levels of incorporation. On the other hand, this is a rapidly moving target and the fish feed industry already substitute with vegetable products to a large extent and many include assurances of the sustainability of the fisheries used. Although this is clearly an important area, increasing the credibility of sustainability accreditations might be the most appropriate solution.

Conclusions

- All countries studied have a regulatory system in place for a systematic study of the costs and benefits of a proposed new salmon farm (EIA). The EIA system has an emphasis on highlighting potentially negative environmental impacts, socio-economic costs and benefits are generally not part of the EIA process and the accepted content of the resultant ES[65] does not specify their inclusion. However in some countries e.g. Scotland, a brief socio-economic analysis is often included.
- Socio-economic benefits are often seen as implicit in EIA, but a more rigorous and explicit approach to assessing socio-economic costs and benefits would be very helpful in allowing decision-makers to balance these against any environmental costs.
- All countries have regulations regarding the monitoring of existing salmon farms to ensure compliance with a variety of environmental standards.
- Salmon farming is expanding rapidly in Chile. While regulations and standards exist, there is a perception that regulatory authorities have insufficient resources to adequately monitor performance and police compliance.
- In most countries there is a perception that regulation does offer protection to the environment. In most cases farmers regard the regulatory process as relatively slow and bureaucratic. This is particularly the case in the United States of America where responders to a questionnaire indicated that development was stifled by the complex regulatory regime.
- In all countries, but particularly in North America, greater dialogue between all stakeholders in a non-litigious arena would be highly beneficial, as there appears to be considerable mistrust between the industry, the regulators and NGO's.
- Interchange of scientists and regulators between salmon growing countries and the willingness to learn from regulatory developments, should be strongly supported.
- All countries need to put greater effort into determining impacts at the waterbody rather than site scale. This requires modelling approaches backed up by long time-series measurements for validation and calibration.
- Improvements in technologies for preventing escapes and in regulation should follow the Norwegian example. Escapes of farmed fish must be reported on a statutory basis, particularly in Atlantic areas.
- Sea lice are a threat to wild populations. Compulsory delousing should be implemented in all jurisdictions (following Norway) and a robust framework of basin-scale co-operation between farmers and wild fish interests regarding synchronous stocking and treatment should be encouraged to minimise medicine use.
- Environmental data collected at farms should be placed in the public domain to increase confidence in the regulatory process.

[65] www.europa.eu/environment/eia/full-legal-text/9711.htm

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TABLE 27
Synthesis table

Environmental monitoring			Norway	United Kingdom	Ireland	Canada	United States of America	Chile	New Zealand
Environmental impact assessment									
When			Prior to consenting a new site or increasing an existing one.	Prior to consenting a new site or increasing an existing one.	If a salmon farm is considered to have a 'significant' effect on the environment.	Prior to consenting of a new site and modification of existing site	Prior to consenting of a new site and modification of existing site	Prior to consenting of a new site	When applying for a new coastal permit or renewing an existing one.
Criteria/Threshold level determining whether an EIA is required			Floating / movable cages ≥48,000m³ permanently sited cages ≥36,000m³	All farms located in a 'sensitive' area and all new farms or existing farms whose biomass ≥100tonnes or cage surface area ≥1000m²	Each farm is considered on a case-by-case basis, the final decision resting with the Minister of the Marine.	Most finfish farms require an EA prior to consent	Most finfish farms require assessment prior to consent	In some cases a DIA may be required but a full EIA is required where additional factors are identified (see Box 2.6.1)	All salmon farms require an EIA as part of their coastal permit to operate.
Sediment related impacts	Determinand	Organic sediment loading	Every month, every second month or every third mo nth depending on degree of exploitation.						The ANZECC guidelines list comprehensive monitoring guidelines which each region adapts for their particular requirements. New Zealand does not apply a generic approach to all farms but tailors the determinands to be recorded for each farm. The ANZECC guidelines includes all the determinands listed here as well as others
		Video transect survey		Annually, between 01/05 – 31/10 within 1 month of peak biomass. Extent of survey level dependant on biomass and flushing time.	Annually during peak biomass or within 30 days after harvesting of a year class.		Twice a year Maine. Annually WA	Annually during peak biomass	
		Presence of macro infauna	Twice a year, every year or every second year depending on level of exploitation			Annually between 1/8 -31/101 NB – part of visual survey			
		pH and redox				Annually within 30 days of peak biomass BC/ Annually between 1/8 -31/101 NB	Twice per year - Apr-May and Aug-Oct Maine. Annually WA		
		Colour, odour and presence of gas in sediment, sediment consistency and thickness				Annually between 1/8 -31/101 NB – part of visual survey			
		Quantitative and qualitative assessment of benthic fauna	Frequency at the discretion of the local authority			Annually within 30 days of peak biomass BC	Once in five years as minimum in Aug- Oct (Maine). Annually WA	Annually during peak biomass	
		Organic content							
		Particle size							

TABLE 27
Synthesis table (Continued)

Environmental monitoring			Norway	United Kingdom	Ireland	Canada	United States of America	Chile	New Zealand
Environmental Impact Assessment									
Sediment related impacts	Determinand	In feed medicine residue		Annually, between 01/05 – 31/10 within 1 month of peak biomass. Extent of survey level dependant on biomass and flushing time.			Within 1 month of use Maine		The ANZECC guidelines list comprehensive monitoring guidelines which each region adapts for their particular requirements. New Zealand does not apply a generic approach to all farms but tailors the determinands to be recorded for each farm. The ANZECC guidelines includes all the determinands listed here as well as others
		Copper Zinc Total volatile solids				Annually within 30 days of peak biomass BC	Once every two years Maine		
		Total Kjeldahl Nitrogen					Annually WA		
		Free Sulphide				Annually within 30 days of peak biomass BC/ Annually between 1/8 -31/101 NB	Twice per year - Apr-May and Aug-Oct Maine		
		Presence of feed pellets/faeces			Annually during peak biomass or within 30 days after harvesting of a year class.	Annually between 1/8 -31/101 NB – part of visual survey	Annually WA		
		% Beggiatoa					Twice per year - Apr-May and Aug-Oct Maine. Annually WA		
	Treatment trigger level/EQS		Yes	Yes	Yes	Yes	Yes	Yes	Yes
	Statutory/ voluntary		Statutory	Statutory	Statutory	Statutory	Statutory	Statutory	Statutory
	Personnel involved		Qualified consultants	SEPA	Qualified consultant approved by DCMNR.	Consultants	Consultants	Consultants	Qualified consultant and/or Regional Council appointed staff.
	Feedback mechanism		Yes	Yes	Yes		Yes	Yes	Yes

TABLE 27
Synthesis Table (Continued)

Environmental monitoring			Norway	United Kingdom	Ireland	Canada	United States of America	Chile	New Zealand
Environmental impact assessment									
Water column related impacts	Determinand	Oxygen content	Frequency of measurement at the discretion of the local authority	Bi-annually, 1 winter survey, 1 summer survey.		No water column determinands monitored as part of annual monitoring (BC or NB)	2/month or 1/wk on site or 1/yr or 2/yr in Aug/Sep2 Maine. Annually WA	Annually	The ANZECC guidelines list comprehensive monitoring guidelines which each region adapts for their particular requirements. New Zealand does not apply a generic approach to all farms but tailors the determinands to be recorded for each farm. The ANZECC guidelines includes all the determinands listed here as well as others
		Salinity			Measured monthly between December and March each year.			Not measured as part of statutory monitoring	
		Temperature							
		Ammonia					Annually WA		
		Nitrate							
		Nitrite							
		Phosphate							
		Chlorophyll							
		Copper							
		Medicines and chemicals						Not measured as part of statutory monitoring	
	Treatment Trigger level/EQS		Yes	Yes	Yes	N/A	No	No	Yes
	Statutory/voluntary		Statutory	Statutory	Statutory	N/A	Statutory	No	Statutory
	Personnel involved		Qualified consultants	SEPA	Qualified consultant approved by DCMNR.	N/A	Consultants and Regulators	Consultants	Qualified consultant and/or Regional Council appointed staff.
	Feedback mechanism		Yes	Yes	Yes	N/A	Yes	No	Yes
Sea lice related impacts	Determinand		Number of gravid females or mobile lice per fish. Monthly at sea temperatures below 4oC, fortnightly at temperatures ≥4oC.	Number of gravid females or mobile lice per fish. Weekly counts throughout the year.	Number of gravid females or mobile lice per fish. 14 counts per year, with bi-monthly counts between March and May.	Sea lice impacts not monitored as part of annual monitoring (BC or NB)	Sea lice impacts not monitored as part of annual monitoring	At present Chile does not monitor sea lice as part of statutory monitoring	New Zealand does not routinely monitor sea lice levels.
	Treatment trigger level		0.5 gravid females, 2 mobile lice per fish during late winter to early spring	0.5 adult female per fish during February to June 1 adult female per fish during July to January	0.3-0.5 ovigerous females per fish during spring. 2 ovigerous females per fish outwith the spring period.			N/A	N/A
	Statutory/voluntary		Statutory	Voluntary*	Statutory	N/A	N/A	N/A	N/A
	Personnel involved		Farm staff	Farm Staff	The Marine Institute	N/A	N/A	N/A	N/A
	Feedback mechanism		Yes	Yes	Yes	N/A	N/A	N/A	N/A

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Appendix 1

QUESTIONNAIRE

SCOTTISH ASSOCIATION *for* MARINE SCIENCE

ENVIRONMENTAL IMPACT ASSESSMENT: SALMON FARMING MARINE CAGE AQUACULTURE CASE STUDY (SALEIA)

Dear colleague

SAMS are conducting a review of the EIA process and environmental monitoring for salmon marine cage farms in Canada, Chile, Ireland, New Zealand, Norway, Scotland and the United States of America on behalf of the Food and Agriculture Organization of the United Nations, Fisheries Department, Rome. I would be very grateful for your input with respect to current practices in Country. I would also be grateful if you could recommend other experts who you consider may have useful contributions to make. All inputs will be acknowledged in our final report and a consulted experts list will be included as an additional output in this study.

I would be very grateful if you could complete the following questionnaire. Please feel free to expand on any point or to skip areas where you feel you do not have sufficient background.

Please feel free to pass this questionnaire to anyone who has an interest in monitoring salmon cage aquaculture in Country.

Sincere thanks for your co-operation in this project. An early response would be very helpful, preferably by 30 October 2006.

Please return your questionnaire to:

Dr Kenneth D. Black
Head of Ecology
Scottish Association for Marine Science
Oban
Scotland
United Kingdom

+44 1631 559259
kenny.black@sams.ac.uk
www.sams.ac.uk

Section 0 Your background

1. Please provide details of your title, name, affiliation, country, email.

(the boxes will expand to fit your responses)

2. How would you describe your role in the EIA monitoring process? (indicate (x) all that apply)

Policy maker	
Regulator	
Scientist	
Researcher	
Industry representative	
Farmer	
NGO	
Other	
Comment	

Section 1. What are the requirements for EIA and monitoring of salmon farms?

Statutory Requirements:
We wish to compile and review the legal/regulatory requirements for conducting Environmental Impact Assessments and presenting Environmental Statements for

1. A proposed new salmon farm development
2. A change of practice on an established salmon farm (i.e. expansion)
3. Regular environmental monitoring (as recommended in the particular E.S.)

3. Can you provide or direct us to sources for this information in Country?

Voluntary Requirements:
4. Do you have any information or know of sources for soft law based recommended practices for carrying out Environmental Impact Assessments and the related environmental monitoring (i.e. codes of practice, voluntary agreements, certification schemes etc.) in Country?

Section 2. How are EIAs done in Practice

We wish to establish the methodologies used in carrying out Environmental Impact Assessments and related environmental monitoring in Country.

5. In general, is there a requirement to collect new data for the preparation of Environmental Statements? If so, which are the most common types of data that are required (e.g., benthic, side scan, nutrient concentrations, water currents)

6. Are modelling approaches used? If so, give examples.

7. If field sampling is required, are sampling methods and equipment prescribed? If not are there any common standards?

8. Are there norms for the degree of replication, the numbers of stations and/or the duration of observation?

9. How is Quality Assurance addressed for field sampling and analysis?

10. Are their prescribed or standardised methods for data interpretation, analysis and presentation?

11. Have these methods been assessed for practicality, cost effectiveness and scientific robustness?

12. Have Ecological Quality Standards been set for benthos or water column?

13. Who carries out any field measurements: the farmers, their consultants, the regulators or others?

14. What are the most important constraints on recurrent monitoring practices – e.g. money, expertise, bureaucracy, access to sites others?

Section 3.
Assessing Effectiveness

15. Is there general agreement between industry, regulators and researchers that the optimum measurements are being made to protect the environment? What is your opinion?

16. Are there good feedback mechanisms between environmental monitoring and improved site selection, aquaculture performance and farm development (including scale)? If there are, how do they work in practice both at the level of the individual farm and at regional or national policy level?

17. Are mitigation measures recommended by the EIA process actually implemented and do they reduce impacts on environmental quality? Give examples if appropriate.

18. Have Environmental Quality Objectives been set? Is there effective environmental monitoring to ensure they are met?

19. Are the legal requirements for EIAs, monitoring practices and procedures regularly reviewed?

20. Do stakeholders have very different perception of the effectiveness of the EIA process? If you are a stakeholder, please describe your views and those of others if appropriate.

Section 4.
Suggested Improvements.

21. Can you identify any constraints relating to technical/scientific, financial, social and legal issues involved in the EIA process?
Can you suggest improvements which may be applied to these areas?

22. In your view, what are the needs for capacity building, competency development and collaboration between producers, producer organizations, EIA and monitoring experts, regulators, NGOs, certifiers, etc. in Country?

23. In your view, which are the most important environmental interactions/effects of salmon culture in Country? Please rank these with 1 as the most serious issue.

Generic issue	Rank (comments)
Benthic/sediment effects	
Nutrients/Water column/Pelagic	
Medicines, chemicals	
Escapes	
Sealice/diesases	
Other	

24. In your view are the most serious impacts well avoided or minimized with current EIA implementation in Country? Can you suggest any improvement to the EIA system and to other regulatory processes or to monitoring?

25. Do you have any other comments related to the way in which the salmon aquaculture industry is regulated in Country?

26. Who else should we send this questionnaire to?

Thank you very much for contributing to this study.

Appendix 2

LIST OF RESPONDENTS

The authors are very grateful to the following stakeholders who responded to the questionnaire:

Canada
Tara Dagget (Sweeney International Management Corp)
Eric Greer (Ministry of Environment)
Kristi Super (Panfish)
Ed Parker (New Brunswick Dept of Environment)

Chile
Jorge Bermúdez (Faculty of Law, Universidad Catolica de Valparaiso)
Alex Brown (FAO Consultant)
Alejandro Clement (Marine Biologist, Plancton Andino)
Jorge M León (WWF Consultant, Universidad Austral de Chile)

Ireland
No respondents

New Zealand
Don Morrisey (National Institute of Water and Atmospheric Research Ltd)

Norway
Arne Ervik (Institute of Marine research, Bergen)

United Kingdom
Sally Davies (Scottish Sea Farms)
Andrew Wallace (Association of District Salmon Fisheries Boards)
Neil Auchterlonie (Scottish Salmon Producers Organisation)

United States of America
Kenneth Brooks (Aquatic Environmental Sciences)
Elizabeth Ellis (Washington Department of Natural Resources)
Jack Rensel (Rensel Associates Aquatic Science)
John Sowles (Maine Dept of Marine Resources)

EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay: a case study

Patrick G. White
Akvaplan-niva AS, Crest, France

White, P.G. 2009. EIA and monitoring for clusters of small-scale cage farms in Bolinao Bay: a case study. In FAO. Environmental impact assessment and monitoring of aquaculture. *FAO Fisheries and Aquaculture Technical Paper.* No. 527. Rome, FAO. pp. 537–552.

ABSTRACT
The development of programmatic EIAs and monitoring programmes for clusters of small-scale cage farmers was promoted in Bolinao Bay, the Philippines. The aim of the study was to develop a methodology for the estimation of safe aquaculture carrying capacity, optimal site selection, zoning of aquaculture parks for sustainable aquaculture development for small-scale farmers.

Aquaculture in the Philippines is an important part of rural development, poverty alleviation and source of livelihood in rural areas. However aquaculture activities are not well-planned, managed, monitored nor regulated, leading to "hot spots" of over-development. Consequently, this led to environmental degradation and lots of fish kill incidents.

The local government units (LGUs) which have jurisdiction over aquaculture management in their own designated areas have not yet realized the importance of ecosystem-based co-management of a shared waterbody. At the moment, the government is encouraging the development of aquaculture parks where zones are identified and allocated for aquaculture development.

The Environmental Management Bureau (EMB) of the Department of Environment and Natural Resources (DENR) enforces the environmental regulations for aquaculture development. The Environmental Impact Statements are only required for aquaculture developments greater than 25 hectares for inland aquaculture and more than 100 hectares for marine aquaculture (total water

FIGURE 1
Fish pen development in Daupan, Pangasinan

COURTESY OF G. JACINTO

FIGURE 2
Fish cage development in Taal Lake

COURTESY OF G. CHRISIANSEN

spread area that will be utilized regardless of how many cages and their sizes). This means that all small-scale aquaculture is exempt from the process.

The government is encouraging the development of mariculture parks which are designated areas where clusters of small-scale farmers are encouraged to relocate to. Mariculture parks greater in area than that mentioned above are subject to so-called programmatic environmental regulations. Significant requirements include:

- **Programmatic Environmental Impact Statement (PEIS) –** an environmental baseline study and an assessment of the carrying capacity of an area to absorb impacts from co-located projects such as those of clustered fish farms (mariculture park or aquaculture park).
- **Programmatic Environmental Performance Report and Management Plan (PEPRMP**) – documentation of actual cumulative environmental impacts of co-located projects describing the effectiveness of current environmental mitigation measures and plans for performance improvement.

TABLE 1
Environmental Management Bureau (EMB) requirements for aquaculture

Category	Applied to	Required documents
A-1: New	Co-located projects	Programmatic Environmental Impact Statement (PEIS)
	Single projects	Environmental Impact Statement (EIS)
A-2: existing and to be expanded	Co-located projects	Programmatic Environmental Performance Report and Management Plan (PEPRMP)
A3: operating without Environmental Compliance Certificate (ECC)	Single projects	Environmental Performance Report and Management Plan (EPRMP)

This case study is a summary of work undertaken by the Norad funded EMMA project (Environmental Monitoring and Modelling of Aquaculture impact in risk areas of the Philippines) and the EU FP6 funded PHILMINAQ project (Mitigating impact from aquaculture in the Philippines (www.philminaq.eu).

CASE STUDY AREA – BOLINAO BAY, PANGASINAN

The investigations in the Norad funded EMMA study focussed in three hot-spot areas of Taal Lake (freshwater), Dagupan estuary (brackish water) and Bolinao Bay (marine). Bolinao Bay is located in the North West of Luzon Island between the northeast mainland of Cape Bolinao, Santiago Island and Cabarruyan Island (Figures 3-5). The bay has three inlets/outlets. The two up in the northern part of the bay are connected straight out to open water. However, the southern entrance is connected to Tambac Bay which also has a lot of aquaculture activity. The Tambac Bay was also affected by fish kill episodes. The studied bay is relatively shallow and the average depth in most of the area is less than 6 meters deep.

The main cultured species is milkfish (*Chanos chanos*) grown in fish pens and fish cages and oysters (*Crassostrea iredalei)* on stakes. A fish pen is built in shallow waters and is made up of bamboo poles surrounded by a fish net. A fish cage is located in deeper waters and uses either fiberglass or steel and nets held up by floaters.

Permits are issued by the two local government units (Bolinao and Anda) but numbers of structures (cages, pens and oyster farms) counted were way above the number of permits issued indicating the existence of illegally constructed structures. Overstocking and excessive feeding practices were claimed to cause deterioration in water quality that affects both the aquaculture industry and the non-cultured species.

FIGURE 3
Location of Bolinao Bay

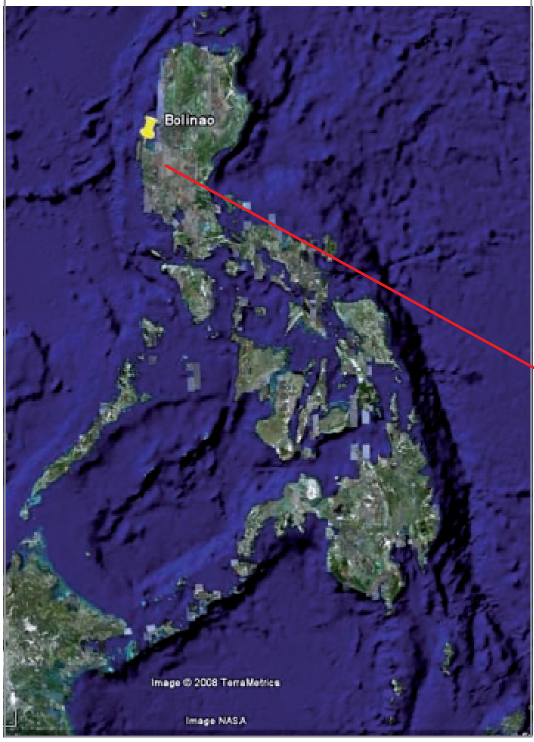


FIGURE 4
Satellite image of the Bolinao Bay

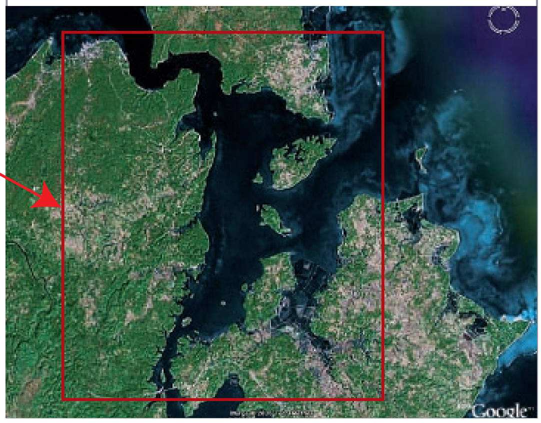


FIGURE 5
A digitalised map of the area. Area included in this study is within the red square

REGISTRATION OF FISH FARM STRUCTURES IN BOLINAO

A full registration of cages, pens and oyster farms was made recording the position of each with a GGIS reading and noting if it was operational or not. Interviews were undertaken with a sample of producers to determine the range and average productivity.

Fish cages

The main areas for fish cages are in the deeper channels and close to the entrances of the bay and especially in the northwest entrance (Figures 6 and 7).

In April 2005 there were 460 fish cages of which 322 were operational (70 percent) and 138 were not operational (30 percent). The average fish cage is square (12 m x 12 m) or circular with a diameter of 12 m and had a volume of 1 155 m^3, stocked with milkfish and holding a biomass of 11.5 tonnes. Fry were stocked at 2 g size and grown to a market size of 433 grams in 6.8 months. The fish were fed at 2.8 percent per day using 320 kg of feed per day per cage. The feed conversion rate was 2.8:1. The total feed fed per day was 103 tonnes of feed and the total production per year from cage culture was 8 867 tonnes.

FIGURE 6
Example of a typical fish cage

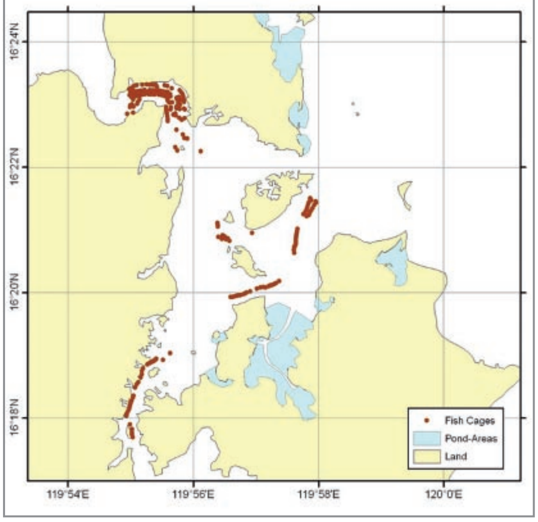


FIGURE 7
Map illustrating the location of fish cages

FIGURE 8
Example of a typical fish pen

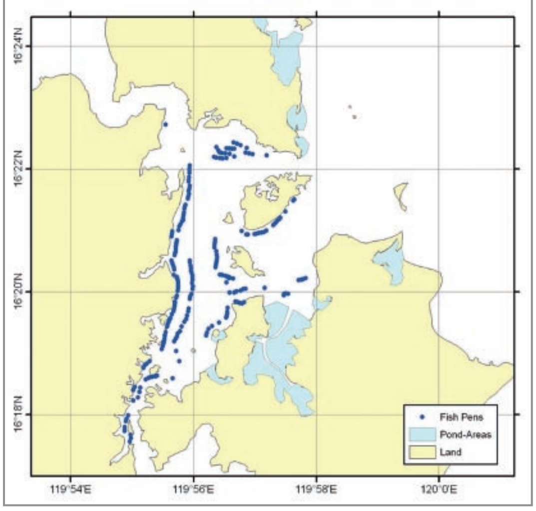


FIGURE 9
Map illustrating the location of fish pens

Fish pens

The main areas for fish cages are in shallow areas close to the coastline especially the western side of the bay and to Santiago Island and Cabarruyan Island (Figures 8 and 9).

In April 2005 there were 266 fish pens of which 217 were operational and 49 were not operational. The average fish pen is 120 m x 120m and has a volume of 14 037 m^3 and stocked with milkfish. It is stocked with fry at 2g size and is grown to a market size of 466 grams in 4.17 months. The average pen has a biomass of 15.2 tonnes and a stocking density of 1.04 kg/m^3. The fish were fed an average of 3.5 percent per day using 540 kg of feed per day per pen and a total of 117 180 kg of feed per day. The average food conversion rate was 2.2:1. The total production per year from pen culture was 14 467 tonnes.

Oysters

Interviews were undertaken with producers to determine the range and average productivity. The main oysters farm activity was spread out in the whole bay but the most intensive areas are in the mid and southern part of the bay (Figures 10 and 11).

There were 254 oysters farms of which 253 were operational and one was not. The average oysters farm had 1 000 poles with an average length of 3.25 meters per pole. Oysters are grown to a market size of 5 centimeters and there are 2 crops per year. The average pole of 3.5 meters gave a crop of 6.5 kg of oysters. The total production from all the oysters farms was 1 638 tonnes.

FIGURE 10
Example of a typical oyster stakes

FIGURE 11
Location of oyster farms

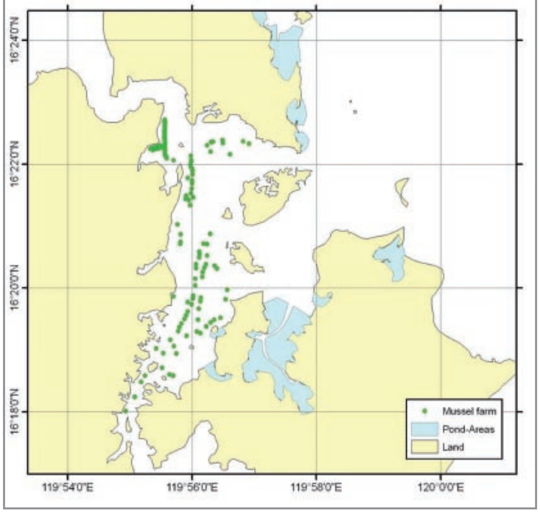
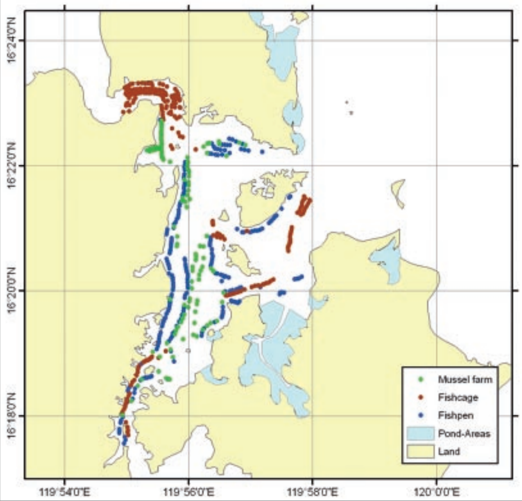


FIGURE12
Map illustrating all the aquaculture activity in Bolinao Bay. Green dots indicate oysters farms, red dot indicates fish cages and blue dots indicate fish pens.
Light blue colorations indicate areas with fish ponds



Total structures

There were 322 operational fish cages out of a total of 460 fish cages. There were 217 operational fish pens out of 266 fish pens. There were 253 operational oysters farms out of 254 giving a total of 792 operational structures out of a total of 980 structures (Figure 12).

The sea surface area in Bolinao is 28 882 031.86 m^2 (not including the islands) i.e. 2 888 hectares. In 2005, the total annual production for fish pens and cages was 23 334 tonnes and there was an annual production of 1 638 tonnes of oysters (extractive species). The total production was therefore 8.07 tonnes of fish and 0.56 tonnes of oysters per hectare of the bay.

ENVIRONMENTAL MONITORING AND MODELLING

Environmental monitoring was undertaken to investigate the environmental impact of the fish and mollusc production. Modelling was undertaken to estimate carrying capacity. Hydrographic modelling was also undertaken to assess residence time and predictive modelling to estimate impact on the sediments and identify the optimal areas for siting zones and distances between zones.

The data needed for environmental monitoring is different for physical, chemical and biological parameters. In most cases there is a need for field trips to collect new data. However historical data are also really useful information both for the modelling but also the environmental monitoring. When historical data and new data were collected these were used to do the modelling work. It is important to remember that the better the background data, the more precise the output of the modelling will be.

The most important parameters for environmental monitoring and modelling are:

- Bathymetry (depth recordings) of the area
- Tidal range and current speed, direction and dispersion
- Physical parameters including temperature, turbidity, salinity, oxygen, profile through the water column

- Water quality – chlorophyll, phosphorous, nitrite, ammonia
- Sediment analysis (biological and chemical)
- Weather data - wind direction, speed, temperature.

FIGURE 13
Bathymetry with depth in meters. The depths are colour coded between 2 m (red) and 22 m (blue)

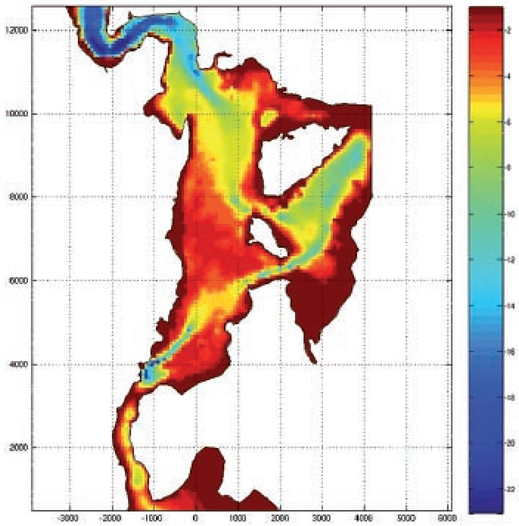


FIGURE 14
Secchi-disk readings in Bolinao Bay 2005

Bathymetry

Detailed knowledge about the bathymetry in an area is vital information for being able to model the water exchange in an area. Sea maps exist with depth recording for the Bolinao Bay but the resolution (number of recordings) was not good enough for the modelling. Therefore, depth measurements were taken of the whole bay including detailed measurements in the entrance channels. To do this, a Garmin echo-sounder which contains a GPS and a chart plotter (GPSmap 178C Sounder) was set up on a boat so that depth readings could be collected. This setup measured depth with an echosounder and a GPS stored the tracks automatically tagged with the date and time of creation, as well as water temperature and depth (Figure 13).

Turbidity sampling (Secchi-depth)

The use of a Secchi-disk is a very well known method for measuring the water-transparency and the colour of the water (Figure 14). These data gives information about the amount of particles in the water. The particles are either related to production in the water column (phytoplankton) or particles which come from the drainage area or sediments (sand, dust).

The Secchi-depth varied from less than one meter to more than 7 meters (Figure 15). The Secchi-depth was generally lower in the area close to the southern entrance. The reason for this, even though the area has a good water exchange is that the water coming in through the southern channel has its origin from Tambac Bay were the Secchi-depth also is low. The Secchi-depth in the outer part of the northwest and northeast entrance is markedly better due to water with little particles coming in from the open sea.

Sediment sampling (Benthic stations)

Sediments are often used as indicators for evaluating the environmental status of an area. It takes much longer time to change the condition of the sediments compared to the water quality parameters. Water quality parameters give a snap shot of the conditions while sediments tell you how the conditions have developed over a longer

FIGURE 15
Secchi-disk measurements from the Bolinao Bay April 2005 and February 2006. The colour of the dot indicates the Secchi-depth in meters

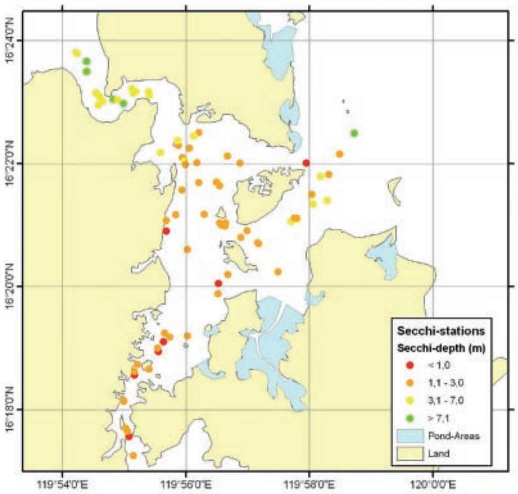
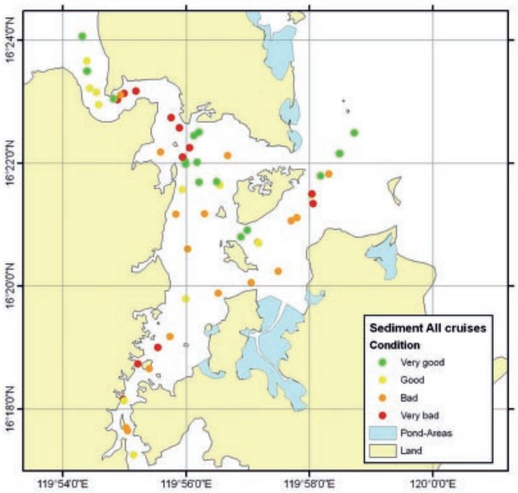


FIGURE 16
Sediment sample collection in Bolinao Bay 2005

FIGURE 17
Illustration of the sediment conditions on 52 stations. Green dot indicates "Very good" conditions while red dot indicates "Very bad" conditions



time period. Therefore the sediment samples are very good indicators of the environmental condition (Figures 16 and 17).

Sampling was carried out with a 0.05 m^2 modified van Veen grab. The grab had hinged and lockable inspection flaps constructed of 0.5 mm mesh. The upper side of each flap was covered by additional rubber flap allowing water to pass freely through the grab during lowering, yet closing the grab to prevent the sediment surface being disturbed by water currents during hauling.

Each sediment sample was described with respect to sediment type, smell, colour, larger living animals and any other obvious features (i.e. visible organic layer, bacteria, faeces, fish food etc.). Further samples were taken for chemical analysis, grain size and fauna analysis.

In Bolinao all the sediment samples were evaluated visually and by smelling the sample. In areas with bad environmental conditions the sediments had high organic content and smelled H_2S. In these samples there was no recording of any live animals. Stations with bad sediment conditions were often related to areas with high fish farming activity. In areas with less fish farming there were no H_2S smell or high organic content and there were also recorded live animals.

Water column sampling with the CTDO-probe

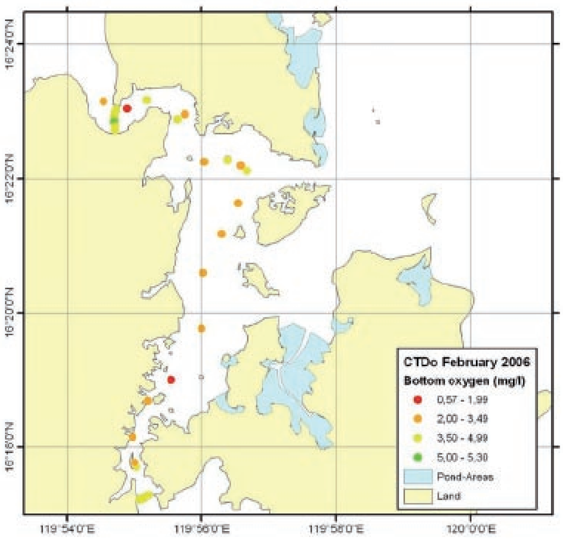
Information about conductivity, temperature, salinity and oxygen in the water column is important for understanding the condition and the dynamics of an area. In addition these parameters are essential for the modelling work. These hydrographic data was measured with an electronic CTDO-probe (sensor data). The probe that was donated to BFAR has sensor for measuring conductivity (salinity), temperature, depth, chlorophyll, turbidity and oxygen. These are all important parameters for evaluating the conditions of the water column.

During sampling the probe was lowered slowly to the bottom and slowly pulled back to the surface. The probe was programmed to take measurements every 5 seconds. The measured parameters will have seasonal and day – night changes. Approximately 100 CTDO readings were collected (Figures 18 and 19).

FIGURE 18
Sampling with the CTDO-probe

The oxygen levels in the bottom water of Bolinao Bay measured in February 2006 varied between 0.57 mg/l and 5.3 mg/l. Generally the lowest levels were found in the southern part of the Bolinao Bay. Low levels of oxygen in the water indicate little water exchange with little new oxygenated water coming in to an area. Further areas with little oxygen are in this case also related to the areas with high aquaculture activity. Release of nutrient (feed spill and fish faeces) to the water increase the production of phytoplankton which again increases the demand for oxygen.

FIGURE 19
Oxygen levels in bottom water of the Bolinao Bay measured with the CTDO in February 2006



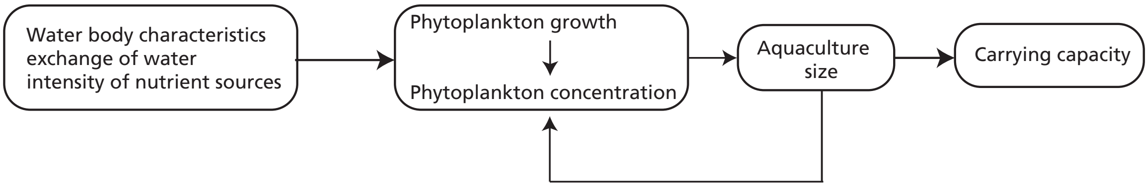
MODELLING CARRYING CAPACITY

Environmental carrying capacity for fish aquacultures is defined as the maximum number of fish of a given species that may be safely grown in the considered waterbody. The maximum number is limited by a variety of factors. Certainly, if the maximum number exists for a single aquaculture occupying a given area, then the available area for fish cultures induces the upper limit. However, this limit may be much higher than the carrying capacity. Computation of carrying capacity must be based on the condition which limits the stock maximally. In other words, it must be based on the limiting condition.

A well known condition which would limit the maximum number more than the available area is the oxygen content in water. Dissolved oxygen is used by fish and its content must not fall below a certain limit. During a normal sunny day, fish in high density is one of the major oxygen users. However, not all days are sunny. During several overcast days phytoplankton in high concentration is orders of magnitude more intensive user of oxygen and hence one must ensure that phytoplankton is not able to reach very high concentration. Otherwise, within a few days, phytoplankton will decrease oxygen content to a value which will dramatically increase fish mortality. Since fish in aquaculture emits its waste to the waterbody, and this waste contains nutrients used by phytoplankton, increasing the fish stock will cause unacceptably high phytoplankton concentration in water. Hence this will limit the standing stock of fish that we may have in the waterbody.

Figure 20 depicts the process graphically.

FIGURE 20
The process of determining carrying capacity for fish aquaculture based on arriving at the critical phytoplankton concentration



The assumption is that the nutrient concentration in phytoplankton is proportional to phytoplankton concentration.

Residual nutrient levels in the bay will be dependent on

- Inputs of nutrients from aquaculture
- Inputs of nutrients from other sources
- Inflow of nutrient: inflow of water x concentration in the inflow
- Outflow of nutrient: outflow of water x concentration in the outflow
- Loss of nutrients by phytoplankton uptake

Phytoplankton requires many nutrients to grow. It is assumed that there is a single nutrient which limits the production of phytoplankton. In order to find which nutrient is limiting at a given time, the correct approach would be to undertake separate experiments for each potentially limiting nutrient, i.e. by increasing one nutrient while keeping the others the same as they occur in the waterbody, and see if phytoplankton grows faster. The procedure would need to be repeated with all candidates for a limiting nutrient. The candidate nutrients are: reactive nitrogen, reactive phosphorus and reactive silica.

From a number of experiments of the above kind it is known that for lakes and brackish waters the most likely limiting nutrient is phosphorus. Hence for these kinds of environments it is advised to take phosphorus as the limiting nutrient.

Based on short-term responses of coral reef micro-phytobenthic communities to inorganic nutrient loading Dizon and Yap (1999) found that N and P are limiting when added together while neither N nor P seems to be limiting when added alone. In the absence of carrying capacity models validated for this area, the EPA criteria and Florida Lakewatch model were used.

According to US Environmental Protection Agency (EPA), the maximum allowable total P should be 0.17 mg/l while the maximum allowable phytoplankton related Chl-a should be 10 µg/l.

Assuming that P in water is found almost exclusively in phytoplankton, then by using a relationship between Total P (TP) and Chl-a, the upper value of Chl-a corresponds to total P found in water. From an analysis of 534 Florida lakes, the following relationship has been found by researchers at the Florida Lakewatch (2000):

$$\text{Log10 } (\mu g \text{ Chl-a/l}) = -0.369 + 1.053 \text{ Log10 } (\mu g \text{ TP/l})$$

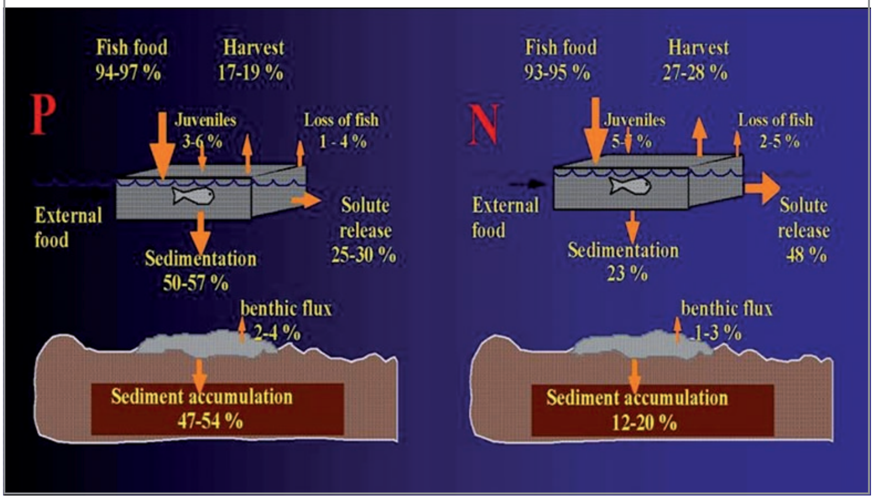
It is instructive to keep in mind (Florida Lakewatch, 2000): "In Florida, when chlorophyll concentrations reach a level over 40 µg/l, some scientists will call it an algae or algal bloom."

"When algal biomass exceeds 100 µg/L (measured as chlorophyll concentrations), there is an increased probability of a fish kill. Fish kills, however, typically only occur after three or four cloudy days. During this time, algae consume oxygen rather than produce it because they don't have sunlight available to help them photosynthesize more oxygen. This can lead to oxygen depletion. Without oxygen, aquatic organisms, including fish, die. Chlorophyll concentrations below 100 µg/l generally do not adversely affect fish and wildlife, but dead fish and wildlife can occasionally be found."

Season variation in carrying capacity

Phytoplankton dynamics will be driven by nutrient inflows to the bay from aquaculture, rivers and human activities. In the dry season, there are low river water flows into the bay but with high nutrient concentrations. In the wet season there will be high river water flows but with lower nutrient concentrations. However, during the first heavy rains of the wet season, there will be high river flows combined with high concentrations of nutrients flushed into the bay (Figures 21 and 22).

FIGURE 21
The theoretical nutrient flow model used for estimating contribution from aquaculture



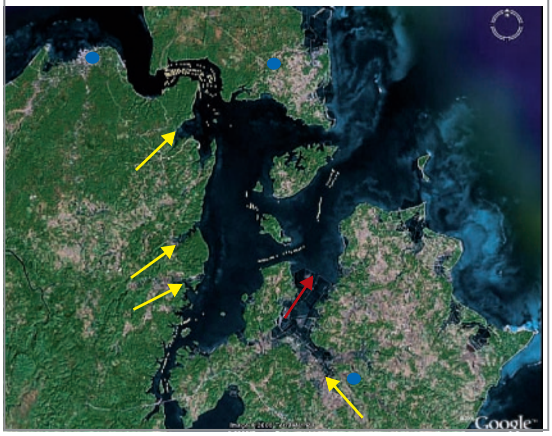
Estimation of nutrient input by aquaculture was made by using nutrient mass balance modelling.

Excretion of phosphorus from aquacultures was estimated to be 339 kg/day, a contribution from soluble faeces is 143 kg/day and resuspension from the bottom is estimated at 94 kg/day. Together, this amounted to 576 kg/day at maximum production (Unpublished calculation. Personal communication.). Bolinao Bay has a surface area of 28.88 10^6 m^2 with an average depth of 4.8 m leading to the volume V= 138.6 10^6 m^3. Residence time of particles at Bolinao, according to Magdaong and Villanoy (2003) hydrodynamic model, varies from several days to over 25 days, with an average of 20 days. During a neap tidal cycle, the corresponding contribution to the phytoplankton concentration was calculated to be equivalent to of 86 µg Chl-a/l. An estimation was made of the nutrient outputs from aquaculture, rainfall, catchment areas and estimated average nutrient flows in rivers, estimate nutrient outputs from semi-intensive ponds and per capita average nutrient flows for urban areas. The contribution from other sources was estimated to be 37.4 µg Chl-a/l equivalent. Therefore, nutrient contributions were:

- Aquaculture 86 µg Chl-a/l
- Other inputs 37.4 µg Chl-a/l

The total combined nutrient input gave an estimated total algae equivalent of 123.4 µg Chl-a/l which breaches the 100 µg Chl-a/l threshold and indicates that the bay is at high risk from algal bloom formation.

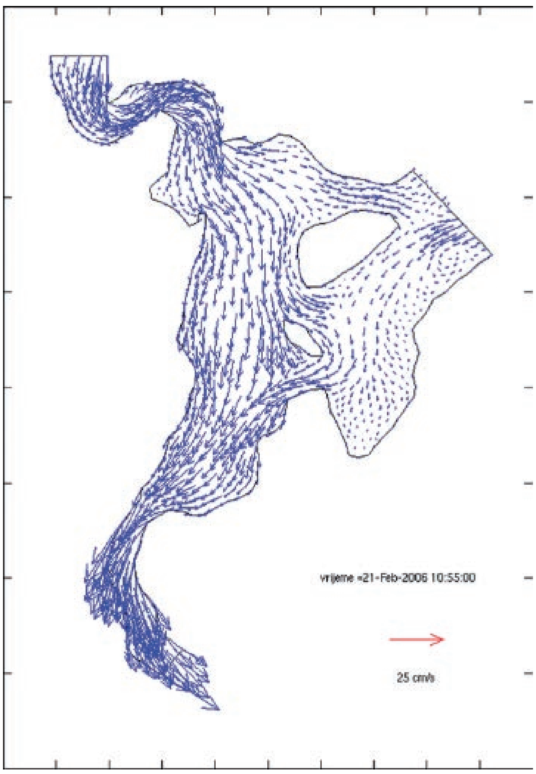
FIGURE 22
Other sources of nutrients into Bolinao bay. Rivers and streams (yellow), pond effluent (red) and urban sources (blue)



Hydrodynamic modelling

The currents in the bay were modelled. The bay was divided into triangular prisms with variable depth. The prisms are of variable density: finer definition was necessary in straits (smaller prisms). Using these divisions, a hydrodynamic model was run. While moving through the bay, at shallow locations and especially at areas with developed coral reefs, water encounters more friction and hence it goes slower. According to Reidenbach *et al.* (2006) in such areas we expect the friction coefficient to be about 2.5 higher than in the rest of the bay (Figure 23).

FIGURE 23
A snapshot of the obtained current field. The current field is displayed for 21 February 2006 at 10 h and 55 min



Modelling residence times

The velocities generated by the hydrodynamic model were used to simulate the transport of passive particles which form the basis for estimating residence time. The model was run for 35 days. Particles close to the openings leave the bay within a day or two while particles released in the central-east side of the bay, take as much as 30 days. In some areas of the bay particles do not leave the bay even after 35 days. However, these locations are very few. Locations of very long residence times of water particles mean higher nutrient levels and smaller carrying capacity (Figure 24).

Methodology for selecting optimal aquaculture zones

It is difficult to prescribe a standard methodology for mariculture site selection because different sites have their own set of characteristics and one approach that works for one site may not work for another. The PHILMINAQ project criteria for the selection of zones was that the zones should have sufficient current and short residence time for flushing the cages, sufficient depth and not be located in any critical entrances.

For a tidally-dominated circulation, it is important to note that the magnitude of the flow also depends on the depth. For instance, flow from relatively deep water must speed up to conserve volume once it flows along shallow bathymetry. The availability

FIGURE 24
Residence times of particles released at every location in the bay. X and Y coordinates are in meters. Residence time is colour coded from 5 days (blue) to 35 days (red)

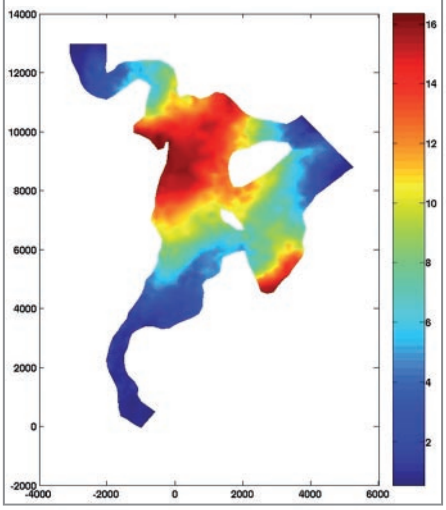


FIGURE 25
Average current speeds and depth

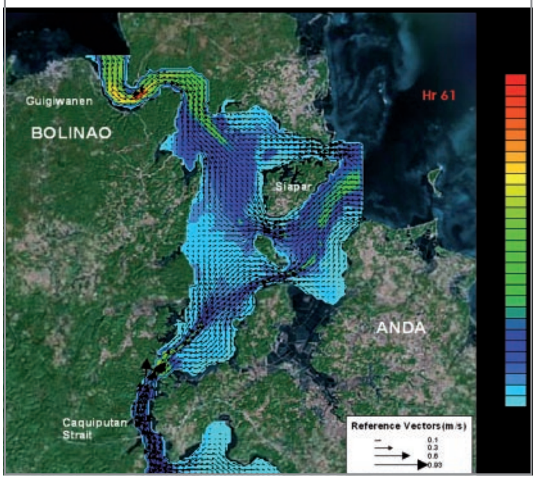
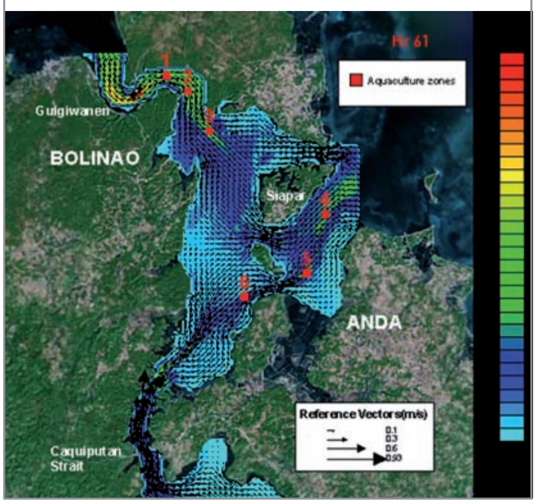


FIGURE 26
Important passages for navigation and flushing



of current speeds and bathymetry in an area can provide useful information in mapping potential mariculture zones.

Flow fields of current speed and direction were calculated from model tidal constituents to give a time series of depth-averaged current speed and direction for 1 month for each zone (Figure 25).

Critical entrances for navigation and water exchange

Critical entrances should be free from aquaculture structures in order to provide enough space for navigation and to allow unobstructed flow of water. These passages are typically the entry or exit points of exchange with the open sea. Minimum space for navigation should allow two-way traffic of the widest boats (typically large boats with outriggers) (Figure 26).

Using modelling to identify Aquazones

The criteria were evaluated and six aquaculture zones identified.

A depositional model TROPOMOD was developed and linked to the hydrodynamic model flow fields provided by Villanoy and Magadong. TROPOMOD is a particle tracking model used for predicting output, movement and deposition of particulate waste material (with resuspension) and associated benthic impact of fish farms. Simulated particles exiting the fish cage are displaced by currents and random walk eddy dispersion and deposit on the sea bed. This data is used to predict impact on the sediments.

Clusters of cages were modelled using the average size of cages and with typical stocking and harvest rates.

Using model validation data sets from MERAMOD and DEPOMOD the threshold of 75 g m^{-2} d^{-1} was used as the definition for SEVERE impact (Figure 28). From the Bolinao sediment trap data sets for waste feed and faeces, stations which had 114.0 g m^{-2} d^{-1} (0 m) and 148.7 g m^{-2} d^{-1} (25 m) were devoid of fauna. For model predictions of above 15 g m^{-2} d^{-1}, impact has been detected with MERAMOD and DEPOMOD validation data sets. Also, recent data sets from shellfish farms in Canada show that 15 g m^{-2} d^{-1} was a useful threshold, above which moderate impact was measured (Weise *et al., in prep*).

The threshold of 1 g m^{-2} d^{-1} can be used as a guide for the distance between the cages and sensitive habitats such as corals, posidonia beds etc.

Using TROPOMOD, three rows of cages were tested for each aquaculture zone (Figure 27). The area of HIGH and SEVERE impact was found to occupy the majority of the zone area and little area was available between rows for remediation of impact (Figure 28). Thus, in all aquaculture zones except zone 4, two rows of 18 cages were found to be optimum. As larger cages were present in zone 4, two rows of 12 cages were recommended.

For the six aquaculture zones, a spacing of 20 m between cages in the same row and 120 m between neighbouring cage rows was recommended to prevent severe impact underneath the cages. The exception was zone 4, which had large circular cages so a spacing between cage centres of 30 m was recommended. Also, the spacing between cage rows was adequate to allow impact to be minimised on areas between cage rows, thus allowing remediation of sediments between rows.

In addition to spacing recommendations, two scenarios were presented for each zone, one for a high (inefficient) Food Conversion Ratio - the current situation - and one for an improved situation with a lower (more efficient) FCR. These scenarios with a lower FCR showed how the environmental impact could be minimised by using better quality feed. This better quality feed used in the model did not break up so easily and also had better digestibility. This meant that the model could be used to show that careful use of better quality feed with less wastage, resulted in a reduction in impact at the zones.

The model was also used to predict the change in environmental impact if Food Conversion Rate (FCR) was improved. The model showed that by reducing feed wastage and feeding less, the area of the zone impacted was reduced to around 35 percent in most zones. In most zones also, the area of the zone classed as SEVERE impact was reduced to less than 1 percent when a FCR of 2.0:1 was used (Figure 29).

The model can be used to give an indication of the minimum distance between zones so that there is no overlap between affected areas here called footprints (Figure 30).

FIGURE 27
Aquaculture zones 1 to 6

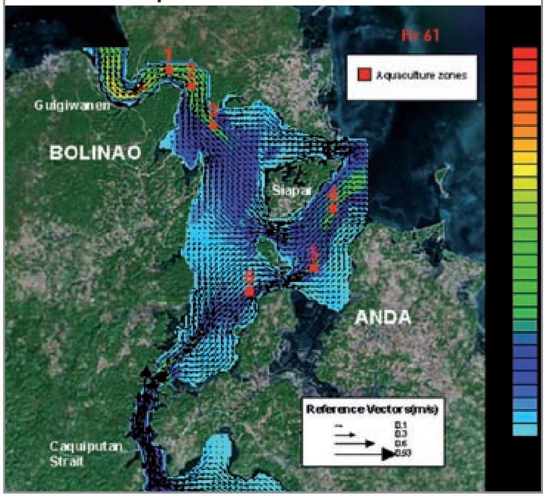
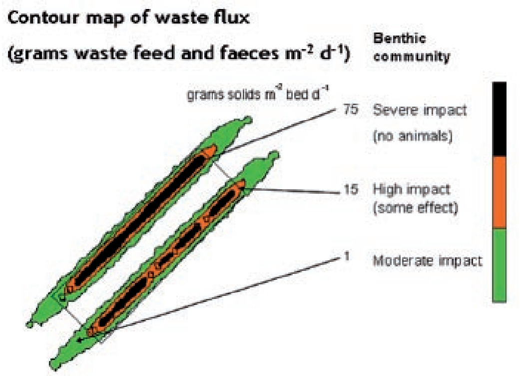


FIGURE 28
Definition of Severe, High and Moderate impact for the SABBAC zone modelling. There are two rows of cages shown and different colours represent different amounts of waste flux (grams waste feed and faeces depositing on the bed per m² per day)



SABBAC = Sual, Anda, Bolinao, Bani and Alaminos City

FIGURE 29
Improvement in severity of impact with improved FCR

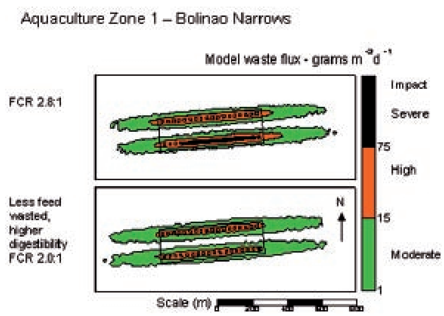
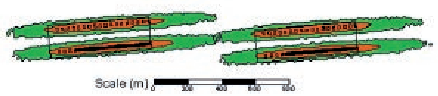


FIGURE 30
Over lap between sediment footprints between zones



As the deposition footprints extend between 200 and 400 m from the edge of each zone, it was recommended that the distance between zones should be a minimum of 600 m.

Monitoring

In addition to the modelling of aquaculture impact, the PHILMINAQ project developed three types of survey for monitoring the impact of aquaculture. These ranged from low cost through intermediate to fully scientific surveys and differ in terms of cost, complexity and accuracy but all give a good indication of the level of aquaculture impact.

The surveys can be used for the following purposes.

- Check level of impact
- Check extent of impact
- Check if
  - production over carrying capacity
  - too many licenses issued
- Check if impact
  - getting worse,
  - staying the same,
  - getting better

Three Categories of surveys were developed. Each category could collect and analyse the necessary parameters but at different capital cost, operational cost and accuracy. The 3 categories were as follows:

Category 1. Low cost simple survey that can be undertaken by local government or larger farmer

Category 2. Medium level survey that requires some dedicated equipment that can be undertaken by Government regional offices, Protected Area Management, IFARMCs, Aquaculture parks and other aquaculture management organisations

Category 3. Comprehensive survey (baseline survey) to be undertaken by government research institutes or similar, scientists for EIA, baseline survey or detailed impact studies.

TABLE 2

Potential users and cost of the different categories of survey

	Category I	Category II	Category III
Level	Simple	Intermediate	Full Quantitative
Client	Large Farmer/LGU	*BFAR Regional IFARMC, PAMBI	Science + Govt Research Institutes
Equipment Cost	USD 1 000	USD 10 000	USD 100 000
Consumables Survey Cost	USD 25	USD 250	USD 2 500

* Bureau of Fisheries and Aquatic Resources (BFAR)
Integrated Fisheries and Aquatic Resources Management Council (IFARMC)
Protected Area Management Board (PAMB)

A field manual of methodology for the 3 categories of monitoring survey was prepared and can be downloaded from www.philminaq.eu.

Conclusions

The conclusions from the two projects were that aquaculture does have an impact on the environment and it can be critical in hot-spot areas of development where the carrying capacity has been exceeded. Mariculture parks are a possible way for governments to control the development of aquaculture by providing zones for clusters of small-scale farmers. Modelling is a good way of identifying zones, estimating the maximum number of cages in a zone, estimating the minimum distance between zones and undertaking scenario testing to identify management options for minimising impact.

Planning aquaculture parks should include Programmatic Environmental Impact Assessment or Statement (PEIA/S) to prevent conflict with other users of the coastline or undue impact to the environment or sensitive fauna or flora. The PEIA/S should also include production carrying capacity estimation for each park. The aquaculture park provides good control of development for the government as it restricts the number of cages to a specific zone that is designated for aquaculture on a long-term basis. It provides a discrete zone that can be monitored on a strategic basis to ensure that production is undertaken in a sustainable manner.

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Countries implementation of environmental impact assessment in aquaculture according to information reported to and collected by FAO

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ABSTRACT

The present study is an analysis of the information reported to and collected by FAO regarding environmental impact assessment (EIA) in aquaculture through several mechanisms. The most important source of information in terms of global scope and permanence in time derives from the reporting by FAO members on the implementation of FAO's Code of Conduct for Responsible Fisheries (CCRF). Other sources of information on EIA are the National Aquaculture Sector Overviews (NASOs) and the National Aquaculture Legislation Overviews (NALOs), that are published in the FAO Web site. FAO has been monitoring the implementation of the CCRF with a questionnaire that is distributed to member countries, Regional Fishery Bodies and Non-governmental organizations (NGOs). Within this questionnaire some portions are related to aquaculture and some are specific to the existence and effectiveness of environmental assessments. The responses provided through this questionnaire offer the information and views of government authorities themselves. The information provided in the NASOs has been primarily provided by experts on aquaculture and by national authorities while NALOs are prepared by desk studies and validated by national authorities.

From the CCRF reporting for the period 2004–2006, and from NASOs and NALOs for the period 2004–2005 it is possible to identify 89 countries out of 131 with some kind of environmental assessment in place for aquaculture activities. However, the CCRF reporting reveals that effectiveness is generally low if assessed at all. Monitoring related to EIA is also rarely mentioned. A current revision to the CCRF reporting system for aquaculture offers an opportunity to consider some issues that can enhance reporting on EIA, monitoring and overall effectiveness. Such reporting should increase the demand for better implementation of EIA as a tool for sustainability of aquaculture.

CONTENTS

Introduction

FAO has been collecting information about the implementation and use of environmental impact assessment (EIA) for aquaculture at a global level through several mechanisms. The most important source of information in terms of global scope and permanence in time derives from the information received from FAO member countries on progress made in the implementation of FAO's Code of Conduct for Responsible Fisheries (CCRF) (FAO, 1995). Other valuable sources of information on EIA in aquaculture, are the National Aquaculture Sector Overviews (NASOs), and the National Aquaculture Legislation Overviews (NALOs) prepared by FAOs Aquaculture Management and Conservation Service (FIMA) and FAOs Development Law Service (LEGN). Both resources are made available online on the FAO Web site.[1]

The CCRF is a *global Code of Conduct* which, in a non-mandatory manner, establishes principles and standards applicable to the conservation, management and development of fisheries, including aquaculture. FAO member governments, along with many stakeholders of the sector, have been involved in implementing its provisions, and FAO has also been assisting its member governments in this process.

The present study utilizes information officially reported by member countries in compliance with the CCRF to provide a global overview of EIA implementation and a short temporal trend in implementation according to these responses. The picture is complemented with data and information obtained from NASOs and NALOs. Since this information gathering process will continue, the present document also analyses potential improvements to it in order to better describe the current use and implementation of EIA in aquaculture and ways to improve its effectiveness.

THE FAO CODE OF CONDUCT FOR RESPONSIBLE FISHERIES

The process leading to the adoption of CCRF was initiated in 1991 by the Committee on Fisheries (COFI) of FAO after a multistakeholder consultation process, and it was formally adopted in 1995 by over 170 Member Governments of the FAO Conference. The CCRF represents the most significant globally recognized international framework for marine, coastal and inland fisheries, including aquaculture. Although a voluntary instrument, the Code also contains provisions that are based on relevant rules of international law, including those reflected in the United Nations Convention on the Law of the Sea (UNCLOS). The CCRF is to be interpreted in light of the 1992 Declaration of Cancun, and the 1992 Rio Declaration on Environment and Development and Agenda 21 adopted by the United Nations Conference on Environment and Development (UNCED). The Code sets out principles and international standards for responsible practices with a view to ensuring the effective conservation, management and development of living aquatic resources, with due respect for the ecosystem and biodiversity. The Articles of the Code cover all major issues and practices in fisheries, including fisheries management, fishing operations, aquaculture development, integration of fisheries into coastal area management, post-harvest practices, trade, and fisheries research; general principles; and provisions related to its implementation, monitoring, updating and the special requirements of developing countries.

[1] National Aquaculture Sector Overviews: www.fao.org/fishery/naso/search/en
National Aquaculture Legislation Overviews: www.fao.org/fishery/nalo/search/en

The CCRF is increasingly being recognized as a reference and framework of basic principles and norms which all stakeholders concerned with sustainable aquaculture development can use as a common platform for better understanding, consultation and collaboration. FAO is required to monitor progress made in the implementation of the Code under article 4.2 of the CCRF.[2]

The CCRF is addressed primarily at States, and stipulates actions that should be taken by States and national authorities and institutions. However, it is also addressed to people, interest groups and private institutions that are involved in or concerned with fisheries and aquaculture. In fact, in the case of aquaculture development, it is evident that responsibilities beyond the local farm level need to be shared by many players. Providing an "enabling environment" for sustainable development in aquaculture, as in agriculture, is therefore not only the responsibility of governments and legislators, but also of the media, financial institutions and Non-governmental Organizations (NGOs), as well as of social and natural scientists, manufacturers and suppliers of inputs, as well as processors and traders of aquaculture products.

Article 9 "Aquaculture development" of the CCRF, covers major aspects of aquaculture (Box 1) and culture-based fisheries, although there are also significant provisions in other sections of the Code having an important bearing on aquaculture and its general development context, for example, recommendations regarding

BOX 1

Implementation of the CCRF regarding Aquaculture Development

As a primary goal, aquaculture development should conserve genetic diversity and minimize negative effects of farmed fish on wild fish populations, while increasing supplies of fish for human consumption.

Resources, such as water, bays or land space are often used by more than one user or have the potential for different uses. To avoid disputes and conflict between different users of resources, countries should have policies and plans to ensure that resources are used and allocated on a fair basis.

Countries should take steps to ensure that the livelihoods of local communities, including access to, and productivity of, fishing grounds, are not negatively affected by aquaculture developments. Procedures for monitoring and assessing the environmental effects of aquaculture should be established. In addition, care should be taken to monitor the types of feed and fertilizer used in farming fish. The use of disease-control drugs and chemicals should be minimal because these can have important negative impacts on the environment. It is also important to ensure the safety and quality of aquaculture products.

Where the effects of fish farming may extend beyond a country's waters, countries should consult with neighbouring countries before introducing non-native species of fish for farming. To minimize disease from new species, countries need to establish mutually agreed codes of practice or behaviour for introducing and transferring aquatic plants and animals from one place to another. In planning aquaculture projects, techniques should be developed by countries and the industry for restoring and increasing the supply of endangered species (those species that may die out if corrective action is not taken).

Source: FAO. 2001. What is the Code of Conduct for Responsible Fisheries? Rome, FAO. 19 p. (available at www.fao.org/docrep/003/x9066e/x9066e01.htm#f)

[2] "4.2 FAO, in accordance with its role within the United Nations system, will monitor the application and implementation of the Code and its effects on fisheries and the Secretariat will report accordingly to the Committee on Fisheries (COFI). All States, whether members or non-members of FAO, as well as relevant international organizations, whether governmental or non-governmental should actively cooperate with FAO in this work."

impacts on local communities, fisheries management, fishing operations, coastal area management, post-harvest practices, and the quality, safety and trade of fish and fishery/aquaculture products.

FAO has been monitoring the implementation of CCRF since 2000 with a questionnaire distributed to member countries, Regional Fishery Bodies and international NGOs.[3] Within this questionnaire some specific portions are related to aquaculture, in particular Article 9, but also some elements from Articles 5 and 10. This questionnaire is distributed every two years, approximately one year in advance to the biennial COFI meeting. For example, the questionnaire for 2006 was distributed in May of that year to countries and other organizations and responses were received in FAO until August. The analysis of responses was then provided in a working document for discussion at the twenty-seventh session of COFI in March 2007 (FAO, 2007). This same information, but with a more detailed analysis on aquaculture issues, is usually presented as a working document at the COFI Sub–Committee on Aquaculture (COFI SCA), which last time took place in October 2008.

The relevance of the CCRF reporting for countries and for FAO

For FAO, one of the main goals of the CCRF questionnaire and reporting on implementation has been to address Article 5 regarding special requirements of developing countries in the implementation of the Code, and to enable FAO and partners to focus development assistance in this regard. The other main goal for FAO is to provide a global perspective on the progress made in CCRF implementation by countries, regions, and by regional fishery bodies. Such reporting is very relevant for the discussions and decisions of both COFI and the COFI SCA since it is clearly understood that effective national institutional arrangements and capacity, policy, planning and regulatory frameworks are essential to support the sustainable development of aquaculture. On the other hand, the information provided by countries on CCRF implementation can be used to improve cooperation among all stakeholders at the national, regional and inter-regional levels.

The CCRF questionnaire and the inclusion of EIA information

The aquaculture components of the CCRF questionnaire were designed to obtain information about the different aspects considered by Article 9, including the responsible development of aquaculture under national jurisdiction, and within transboundary aquatic ecosystems, the proper use of aquatic genetic resources and the development of responsible aquaculture at the production level (FAO, 1995). The questionnaire also includes specific references to EIA.

Question number 14 of the CCRF questionnaire, inviting a description of the legal and institutional framework for the development of responsible aquaculture, gives the opportunity for responding countries to report on the inclusion of EIA within such frameworks. More specifically, questions 16 and 16a refer to the existence of some kind of environmental assessment and also request information about its effectiveness. However, the questionnaire does not provide further information or indication on how to asses effectiveness or how to report on it.

As an answer to the requests by COFI and COFI SCA and with the objective of improving the response rate, quality of responses, and to increase the value of the reporting for members, FAO is currently reviewing the questionnaire and the whole reporting system. One of the problems is that not all the major aquaculture countries complete a CCRF questionnaire and although the information on aquaculture can be

[3] Questionnaire for monitoring the implementation of the 1995 FAO Code of Conduct for responsible Fisheries; the International Plans of Action on Capacity, Sharks, Seabirds, and Illegal, Unreported and Unregulated Fishing; and the Strategy for Improving Information on Status and Trends of Capture Fisheries

complemented with the NALOs and NASOs, the content of these documents is not updated continuously. While the CCRF reporting takes place every two years and therefore it can provide permanent updating of the information which can, in turn, be coupled with FAO statistics using FAO FishStat Plus software (FAO, 2008a).

An important added value of the information and responses provided through the CCRF questionnaire compared with that provided and discussed in other review papers on EIA in aquaculture included in the present volume (FAO, 2009) is that the CCRF responses and often NASOs and NALOs provide the information and views of government authorities themselves.

NATIONAL AQUACULTURE SECTOR OVERVIEWS AND NATIONAL AQUACULTURE LEGISLATION OVERVIEWS

The National Aquaculture Sector Overview (NASO) collection provides a general overview of the aquaculture sector of FAO member countries. The NASOs contain summarized information on the history of aquaculture; human resources involved in the sector; farming systems distribution and characteristics; main cultured species contributing to national production; production statistics; description of the main domestic markets and trade; promotion and management of the sector; and development trends and issues at the national level. The information provided in the NASOs has been primarily provided by experts on aquaculture and by national authorities and, supplemented by graphs created by FAO to illustrate reported production statistics. Ninety five NASOs have been published on the FAO Web site so far.

The National Aquaculture Legislation Overviews (NALOs) are a series of country reports on national aquaculture laws and regulations, prepared by the FAO Development Law Service in collaboration with the FAO Aquaculture Management and Conservation Service. The NALOs reflect the multi-faceted diverse character of aquaculture, demonstrated by the wide range of legislation pertaining to different sectors that governs the sector. The NALOs are tackling as diverse issues as access to land and water, EIA, aquatic animal disease control and food safety. Several of these issues are not unique to aquaculture but are regulated in general laws on e.g. building and planning, environmental law, veterinary control and food processing. Many of the laws and regulations in place today were developed without aquaculture in mind and may therefore be poorly adapted to the requirements of aquaculture or applied in an inconsistent manner. The NALOs were prepared as desk studies based on FAOLEX[4] and national legislative databases, and have been validated by national authorities and experts. Forty two NALOs have been published on FAOs Web site to date.

The majority of NASO's and NALOs were prepared during 2004–2006 periods. However, NASOs will be updated every 4-5 years whereas NALOs will be updated on a regular basis, every 2-3 years.

ANALYSIS OF THE INFORMATION PROVIDED BY CCRF REPORTING, NALOS AND NASOS REGARDING IMPLEMENTATION OF EIA IN AQUACULTURE

From the 166 aquaculture producing countries in the world (FAO, 2008a), the information available on EIA amounts to 131 countries as follows: information from 52 countries comes only from NASO/NALO; information from other 50 countries comes from both NASO/NALO and CCRF reports, and for 29 countries we obtained the information only from CCRF reporting. To facilitate the analysis of information on EIA , the producing countries were divided in seven different regions: Africa, Asia, North America, Latin America and the Caribbean, Europe, Near East and South West Pacific; a summary of this analysis is provided below.

[4] FAOLEX is a comprehensive and up-to-date computerized legislative database, one of the world's largest electronic collection of national laws and regulations on food, agriculture and renewable natural resources. (faolex.fao.org/faolex/index.htm).

EIA in the CCRF responses

In general, since the reporting process started in 2002, the responses from countries to the full CCRF questionnaire have been declining. In 2006, eighty countries (i.e. 55 percent of the countries receiving the questionnaire) responded although this response is slightly better than that of 2004 (67 countries or 45 percent). Nevertheless a large proportion of the main aquaculture countries have responded to both questionnaires (2004 and 2006).

The comparison of the responses for the 2004 and 2006 biennium indicates an increase in the number of countries implementing some kind of EIA. Largest increase in response is mainly presented in two regions: Africa, and Latin America and the Caribbean (Figure 1). In general, according to the answers, EIA seems to be provided for in legislation, but in wider environmental regulatory frameworks rather than in aquaculture specific legislation, and EIA is therefore often being applied to many activities, including aquaculture. In a few countries where aquaculture is just starting, the responses to the CCRF questionnaire indicate some form of EIA (usually devised for other sectors) as initial tool to manage aquaculture in the absence of other regulations more specific to aquaculture.

Many of the reported EIA required for aquaculture refer to large scale activities, however since the questionnaire does not specify a scale, it is not clear if this is the most general case.

Another interesting observation is that there is little relationship between EIA and measures to reduce the risk of using exotic species in aquaculture. In fact from all the responding countries in 2006, only two countries out of 56 reported some specific management measures for the use of exotic species indicating that EIA was required for this specific situation. However five countries where EIA assessment for aquaculture has not been implemented indicated that they have some measures in place to reduce the risk of using exotic species. Indeed, the issue of a permit or licence to farm fish is now very widespread and regarded as a pre-requisite for the initiation of the activity and in some cases several different permits or licences are required (e.g. in relation to water use; waste discharge; chemical use; use of introduced species; conversion of land/habitat, etc.). More recently, when comparing 2004 and 2006 responses, it seems that a license is contingent upon EIA compliance amongst other more specific conditions.

An important element of the present analysis comes from the evaluation of EIA effectiveness in the countries' responses (Figure 2). Only 26 percent of the countries reporting that they use EIA for aquaculture indicate that this environmental assessment is effective or report it as good. Largest absence of assessment is shown in the Near

FIGURE 1
Number of countries that require some sort of EIA for aquaculture according to the CCRF reporting to FAO in 2004 and 2006

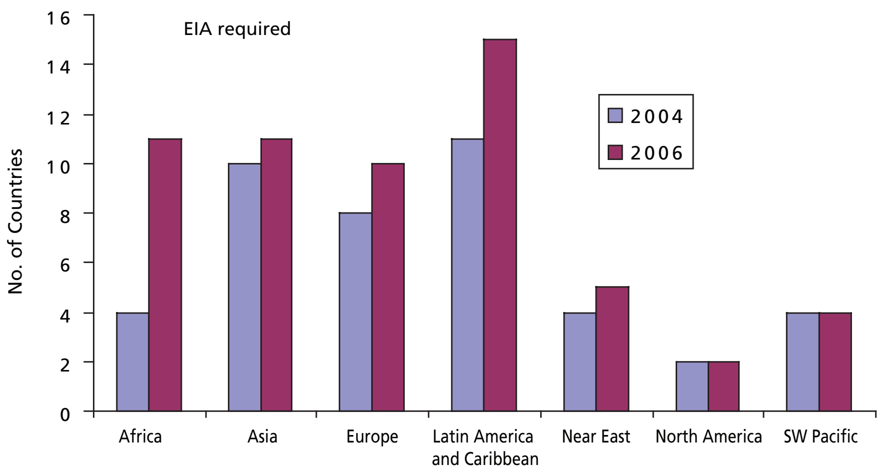
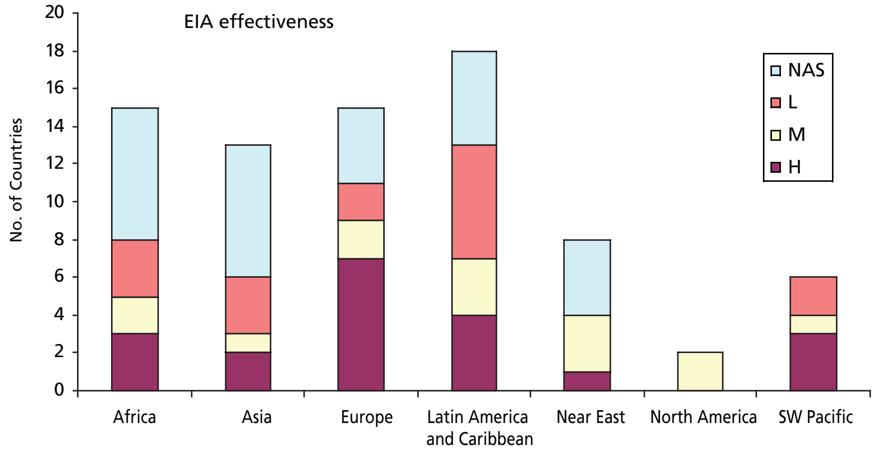


FIGURE 2
EIA effectiveness as indicated in CCRF reporting by countries on each region. The most recent reported information was used (2004 or 2006). Colours represent the assessment of EIA effectiveness; No assessment of effectiveness (NAs); low (L); moderate (m) and high (h).



East, Asia and Africa, while Europe shows the highest number of countries indicating EIA as highly effective. North America's EIA effectiveness is shown as moderate.

None of the countries indicating that EIA is effective mention or describe how they measure or assess effectiveness, and with one exception none of them refer to indicators or other ways to evaluate it. Nevertheless, one country reports EIA as effective and indicates that "they have been very successful in avoiding major disease outbreaks, maintaining resource and environmental sustainability and in meeting social and economic needs of regional communities". However this country refers to the whole suit of management measures that are in place to make aquaculture sustainable and therefore it is difficult to judge EIA effectiveness independently for aquaculture.

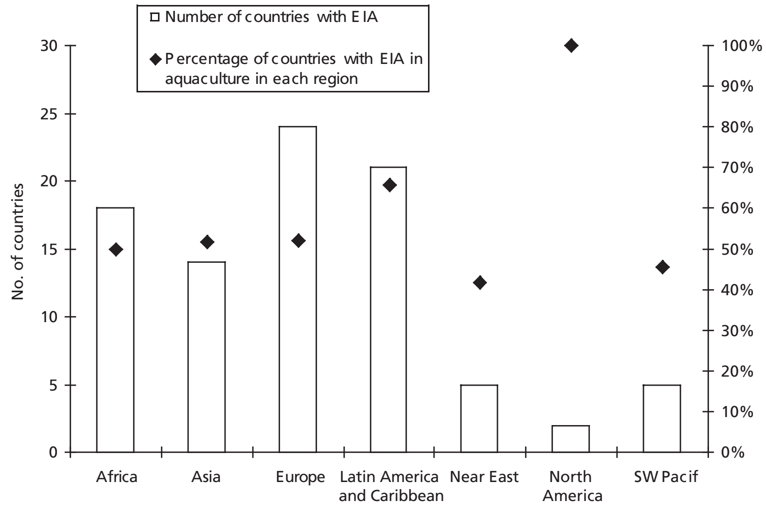
There is also a problem with the understanding of "effectiveness" of EIA. Some countries in their responses describe EIA as effective when it is well implemented in terms of a set of demands and procedures but there is no clear description of the final result or a follow up procedure. Other countries understand EIA as effective when there is an environmental management plan for an activity that has been approved.

Although the questionnaire includes a specific question regarding monitoring of aquaculture operations, the answers are very general and often vague and in most cases there is no specific connection to the EIA. On the other hand, a large number of countries refer to the lack of monitoring systems or capacity for field evaluations and checking effectiveness, while others refer to the absence of guidelines on standards and indicators to be used along the whole EIA process including the assessment of effectiveness. In several countries, EIA is not required specifically for individual fish farms, while other mechanisms are reported to be in place for the management of environmental effects of aquaculture, including planning, regulation, codes of conduct, infrastructure, monitoring and response mechanisms. Finally, an important number of countries report the need for technical training of personnel and suppliers in order to perform adequate EIAs and to be able to check effectiveness.

EIA in NALOs and NASOs

The NALOs provide a good source of information on legal frameworks and regulations not only for EIA, but also for aquaculture planning and operation, including authorization systems, access to land and water, water quality and wastewater, fish movement, disease control, drugs, feed, as well as food safety. However, they do not describe the effectiveness of EIA or monitoring schemes that have been put in place.

FIGURE 3
EIA required for aquaculture activities in different regions based on information available from the CCRF reporting to FAO, and from NASOs and NALOs. Bars indicate the total number of countries per region and the black dots indicate the percentage of countries requiring some form of EIA in aquaculture activities per region. Percentages are calculated over the total number of countries reporting aquaculture production according to FAO statistics (FAO, 2008a)



NASOs mention key information on EIA however in general they do not report on EIA effectiveness and monitoring.

Figure 3 shows the occurrence of EIA in different countries/regions based on information available from the CCRF for the period 2004–2006, and for NASOs and NALOs for the same period. In total 89 countries have requirements for some sort of environmental assessment in place for aquaculture activities and the relative implementation per region is generally around 50 percent while in North America it is 100 percent because both the United States of America and Canada do require environmental assessment procedures for aquaculture.

CONCLUSIONS AND RECOMMENDATIONS

In general, NASOs and NALOs as well as reviews conducted for other purposes, probably provide more extensive and useful information on policies, regulations and the institutional framework for responsible aquaculture than most CCRF questionnaire responses. However, the later are important sources of information and, as mentioned earlier, give indications on countries need for assistance.

Given that the current CCRF reporting system for aquaculture will be modified for future reporting in order to make it more specific and more useful to FAO and to members, a new questionnaire can be more specific about EIA implementation and effectiveness. It could, for example include some indicators of effectiveness that can guide countries improvement and indicate assistance needed, both being very important from FAO's perspective and of great value for member countries. Effectiveness could be related to: i) a well designed EIA in place for aquaculture, e.g. whether it includes screening, scoping and assessment of significance of impacts (FAO, 2009); ii) monitoring after the project starts; iii) the presence of feedback mechanisms and management measures responding to monitoring results.

It will be necessary to modify the questionnaire to provide more guidance on responses and indicators that could be used. A working document discussed in 2008 by COFI SCA IV (FAO, 2008b) suggested a benchmark approach against the most desirable level of management that suits individual countries' conditions and that can be assessed in terms of progress in a stepwise mode. The questionnaire should also provide the opportunity for clear indication of shortcomings in national efforts to implement EIA as an effective instrument to guarantee sustainability of aquaculture.

The COFI SCA IV document proposes that to better understand the progress of CCRF implementation, the information provided in the questionnaire can be sorted into three categories: i) essential mechanisms, without which aquaculture cannot be managed within the CCRF framework; ii) enabling mechanisms, that are necessary to support the implementation of the basic governance instruments, and iii) enhancing measures or mechanisms to further improve the overall management of the sector. In this case the requirement of EIA for aquaculture activities should be considered essential and the implementation of full assessments should be related to the severity and scale of associated environmental risks of the proposed activity. The enabling mechanisms, as a second stage in the progressive CCRF implementation, could include the EIA monitoring and feedback mechanisms and therefore the evaluation of effectiveness could be done at this stage.

The recommendations compiled by Hambrey (2009) in the synthesis review of the present publication should also be considered. For example the CCRF questionnaire should include some question regarding strategic environmental assessment considering the cumulative impact of aquaculture activities. Many countries do not conduct EIA in small-scale aquaculture, however small farms can be too many for the carrying capacity of a waterbody, and although individual farms may have adopted Best Management Practices, the cumulative environmental effect can be overriding.

Another important element to consider in the questionnaire is a clear indication that EIA and monitoring are implemented as part of a wider management framework or "system" for aquaculture that includes a policy and strategy and agreed environmental objectives with associated indicators, standards and reference points. All of these should be part of the essential mechanisms explained above and as such should be clearly reflected in the reporting system.

All of the above elements shall be considered in the design of the new questionnaire for the CCRF reporting to be tested in some countries and to be further submitted to COFI SCA for approval and implementation within the countries.

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PART 2

Report of the FAO Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture

FAO HEADQUARTERS, ROME, ITALY, 15-17 SEPTEMBER 2008

CONTENTS

Acronyms and abbreviations

BMP	Best Management Practice
CoC	Code of Conduct
CoP	Code of Practice
EAA	Ecosystem Approach to Aquaculture
ECASA	Ecosystem Approach to Sustainable Aquaculture (EU Framework 6 RTD project)
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan (arising from an EIA)
EQO	Environmental Quality Objective
EQS	Environmental Quality Standard
GAP	Good aquaculture practice
FIMA	Aquaculture Management and Conservation Service of the FAO Fisheries and Aquaculture Department
IAIA	International Association of Impact Assessment
ICZM	Integrated Coastal Zone Management
IMP	Integrated Management Plan
IWSM	Integrated Watershed Management
MSP	Marine Spatial Planning
NASO	National Aquaculture Sector Overview
NALO	National Aquaculture Legislation Overview
SEA	Strategic Environmental Assessment
TRIX index	A composite trophic status index

Introduction

FAO's Aquaculture Management and Conservation Service (FIMA) organized the Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture which was held in Rome, Italy from 15 to 17 September 2008. The workshop was undertaken as part of Project Component 2 "Environmental Impact Assessment and Monitoring in Aquaculture" of the FAO project "Towards sustainable aquaculture: selected issues and guidelines", (GCP/INT/936/JPN), which was implemented by FIMA with the generous support of the Government of Japan.

The main objective of the workshop was to review the findings of five case studies and a global review synthesis report on environmental impact assessment and monitoring in aquaculture, and to develop an expert consensus view on the present use of EIA and monitoring in aquaculture, based on presentations, experiences and conclusions by case study authors and reviewers, as well as discussions of workshop participants. The workshop prospectus and agenda are given in Annex 1. The workshop was attended by 21 participants (Annex 2). Part 1 of this publication reproduces the four regional case studies, the special study on EIA in salmon aquaculture, the global review synthesis report, as well as two special contributions to this workshop.

Opening of the workshop

Mr Jiansan Jia, Chief of FAO/FIMA welcomed participants and briefly introduced the scope and targets of project component 2: the global review of EIA and monitoring practice, effectiveness, constraints and challenges, with a view to suggesting improvements and providing relevant guidance to further promote responsible development of aquaculture worldwide. Mr Jia's welcome remarks can be found in Annex 3. Following the welcome remarks, all participants provided short introductions of their background and professional interests.

Mr Uwe Barg of FIMA provided a brief background to the project, including its origins in the 1999 Fisheries Ministerial Meeting, and the first and second sessions of the Committee on Fisheries (COFI) Sub-Committee on Aquaculture in 2002 and 2003. These meetings reiterated the need for enhanced efforts by the international aquaculture community to work towards more sustainable aquaculture production practices. In 2003, the Government of Japan decided to support the project "Towards sustainable aquaculture: Selected issues and guidelines", including project component 2 on EIA and monitoring in aquaculture.

Project component 2 facilitated the preparation of five studies. Four regional case studies were prepared to cover the compilation and review of existing EIA and environmental monitoring procedures and practices in aquaculture in selected countries of the following four composite regions.

Africa:	Egypt, Madagascar, Nigeria, South Africa, United Republic of Tanzania, Uganda;
Asia-Pacific:	Australia, China, India, Indonesia, Japan, Malaysia, Philippines, Thailand, Viet Nam;
Europe & North America:	Czech Republic, France, Greece, Hungary, Italy, Netherlands, Poland, Spain, Turkey, United Kingdom, as well as Canada and United States of America;
Latin America:	Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico

A fifth special case study focused on EIA in marine cage aquaculture of salmon in Canada, Chile, Ireland, New Zealand, Norway, United Kingdom and United States of America. A global review and synthesis report was prepared based on these four regional case studies and the salmon aquaculture study.

The expectation of project component 2 was that the conclusions and recommendations of this workshop would target the development of technical and policy advice on improved use of EIA and monitoring approaches in aquaculture as well as on complementary measures useful and effective in further promoting sustainable aquaculture development. Mr Barg emphasised the cross links with the FAO activity on "Ecosystem approach to aquaculture" which is running in parallel.

The key outputs of the project will include:

- Regional reviews on EIA and monitoring in aquaculture in selected countries in Africa, Asia-Pacific, Europe and North America, and Latin America and a special study on EIA and monitoring in salmon aquaculture;
- Global review and synthesis report on EIA and monitoring in aquaculture;
- Workshop report, including findings and recommendations;
- Workshop discussion guide;
- Elements for policy guidance.

These outputs will be published in an FAO Fisheries and Aquaculture Technical Paper.

Format of the workshop

The workshop was chaired by Mr Michael Phillips. Mr John Hambrey acted as workshop facilitator. The workshop included technical presentations and working group discussions. The technical presentations were intended to provide opportunity for all participants to discuss and review the findings resulting from the various case studies, the global review and synthesis, and two special presentations. These presentations included:

i) four regional studies on EIA and monitoring in aquaculture in selected countries in Africa, Asia-Pacific, Europe and North America, and Latin America,
ii) a special study on EIA in salmon aquaculture,
iii) the global review and synthesis of EIA and monitoring in aquaculture, including reference to the workshop discussion guide;
iv) a case study of environmental assessment in cluster farms in Bolinao Bay, the Philippines, and
v) a summary of EIA information from Code of Conduct for Responsible Fisheries (CCRF) reporting for aquaculture and from FAO's National Aquaculture Legislation Overviews (NALOs) and National Aquaculture Sector Overviews (NASOs)

Based on the above technical presentations and a workshop discussion guide (Annex 4), and following a plenary discussion on issues identification and priority setting, participants were divided into three working groups and tasked to examine the main issue areas of (1) environmental management framework, (2) EIA procedures and (3) environmental monitoring, with a view to further identifying critical issues and possible recommendations. The facilitator compiled and synthesized all working group deliberations and outputs, and presented to the plenary a set of conclusions and recommendations, for discussion and consensus among all participants. The final session provided opportunity for participants to discuss key messages of the workshop as well as ways of dissemination of workshop findings and possible related follow-up actions.

The following participants acted as rapporteurs of the workshop: José Aguilar-Manjarrez, Uwe Barg, John Hambrey, Doris Soto and Patrick White. The following provides a brief overview of presentations and discussions. Based on the rapporteurs' notes the discussions were synthesized so that the essence of the discussion and the various points and perspectives raised are presented as fairly and accurately as possible, with some rationalisation to reduce repetition.

Presentation and discussion of review papers

Each of the review authors made a short presentation of their findings, followed by discussions which were chaired by Mike Phillips. All review papers presented are reproduced in Part 1 of this volume.

REVIEW OF ENVIRONMENTAL IMPACT ASSESSMENT AND MONITORING OF AQUACULTURE ACTIVITIES IN AFRICA

Presentation by Chris Nugent

Mr Nugent provided a brief overview of the review paper (see Part 1). In Africa aquaculture is a relatively new industry, and mostly small-scale and low risk. Broadly speaking, development has priority over environmental concerns and the application of EIA to aquaculture has been limited, other than for a few high profile large scale proposals. However, the legislation is relatively highly developed: 75 percent of countries have legislation for EIA of which one third make specific reference to aquaculture. Some pertinent issues for Africa include the differing perspectives of various agencies/departments involved; the possible conflict between internationally approved or promoted national environmental legislation and local traditions, procedures and interests; the complexity of some key environmental issues, such as the introduction of alien or genetically modified species; the bureaucratic burden and costs of EIA if applied more widely or rigorously; and the lack of capacity in many countries to implement EIA and monitoring.

Discussion

Legislation and guidance

While it may be important to introduce EIA laws, awareness should be raised that EIA does not solve all problems, and is not appropriate for all forms of aquaculture. Many countries have been pushed to accept "parachuted" EIA legislation. Some guidance for donors is needed: EIA is not always the solution to environmental management, and it is important not to impose the "EIA bible" and associated impact matrix. Agencies need to look carefully at traditional local and national law which often addresses many of the issues. We need EIA with "local flavour" perhaps building on local laws. In more strategic terms Uganda is perhaps showing the way forward with mechanisms already in place *before* the industry develops.

Screening and scoping

Better screening and scoping is needed to ensure that aquaculture development, especially small-scale development, is not constrained. EIA should focus on high risk developments. There are examples where EIA procedures halted development, for example, shrimp production in United Republic of Tanzania mangrove areas and small-scale lake aquaculture in Zambia. Generally, in developing countries the presumption should be to allow development – subject to basic screening – and to place the emphasis on monitoring rather than EIA for most aquaculture development.

Introductions and strategic environmental assessment

Introduced species would usually be classified as high risk, but how to manage such risk? For example, there are GIFT tilapia in Gambia. Under what conditions may they be used? Similar issues are emerging in Lake Malawi. Is Strategic Environmental Assessment (SEA) at regional or national level appropriate to address such risks? Currently, legal provision for SEA exists in 6 countries in Africa. There is provision for the application of SEA in several countries in Asia, but so far no significant experience of their use in relation to aquaculture.

Human resources development
There is significant need for capacity building on environmental management among farmers, government, and academics. Typically there are general EIA experts rather than aquaculture EIA experts. EIA may be required as part of business plans for large projects, where capacity is not usually a problem because the technical skills can be found for such projects. With support by USAID, the network for Capacity Development and Linkages for Environmental Assessment in Africa (CLEAA) is working to strengthen EA capacity in the region (http://www.encapafrica.org/cleaa.htm).

Institutional issues
EIA has been driven by environmental legislation and regulation, not by sectoral fisheries interests, and there may be differing perspectives between different government departments. For example, different perspectives on environmental impacts lead the Ghana Fisheries Ministry develop a "Fisheries Impact Assessment" which mainly addressed impacts ***on*** fisheries. Role, competence and capacity are all important issues. EIA specialists seem to predominate while sectoral (aquaculture) specialists tend to be spectators in the process. There is a need to ensure cooperation between environment and fisheries agencies. Cross border implications of environmental impacts, for example, trans-boundary impacts on fisheries may require attention of a central or national agency. In general there is very little "sector" level management, despite the existence of waterbody management institutions such as those concerned with Lake Victoria and Lake Kariba. Often there is very little communication between countries. Generally, the allocation of resources to environmental agencies versus fisheries/aquaculture – *i.e.* sectoral management versus environmental management is an important practical policy issue.

The application of EIA for agriculture shows there are differences in approach to aquaculture and agriculture. Sometimes agriculture and business development are permitted relatively easily while aquaculture may suffer disproportionate attention and regulation. Aquaculture seems to be a more obvious point source of nutrients/pollution, and often is a relatively new activity. Aquaculture might fare better were it placed within an agriculture ministry. This is the case in Egypt where regulation is much more related to traditional rights and irrigation than to environmental assessment *per se*. Cages were removed from the Nile under old laws covering issues such as access and navigation. Ironically EIA is now proposed as a means to get them back. We need to avoid situations of: "law but no application" and "application but no law".

Public/stakeholder participation
Participation is new to many, not well understood, and not often utilized. But it can be useful – there are good examples from United Republic of Tanzania. It can open up many important issues. Equally participation can be controversial and may block development.

REVIEW OF ENVIRONMENTAL IMPACT ASSESSMENT AND MONITORING OF AQUACULTURE ACTIVITIES IN THE ASIA-PACIFIC REGION

Presentation by Michael Phillips
Mr Phillips introduced his presentation on the Asia-Pacific review (see Part 1) with a comment on available information. The review was specifically asked to cover a)

requirements; b) practice; c) effectiveness; and c) improvements. In practice while plenty of information is readily available on requirements, there is much less on implementation and practice, and very little indeed on effectiveness. To address this deficiency would require much more detailed and participatory case studies. Some key points made included:

- Many countries in the region are moving toward more decentralised systems, which is to be welcomed in many respects, but may be constrained through lack of skills and capacity at local level.
- Environment or fisheries departments may be assigned the lead role lead in terms of EIA and environmental management of aquaculture.
- EIA is rarely seen as an environmental management tool by farmers.
- EIA thresholds are typically area based rather than risk based.
- Carrying capacity remains largely a research issue with limited application to date.
- There is very limited experience of the use of Strategic Environmental Assessment in aquaculture. .
- Links between monitoring and management are usually poor, though there are good examples (*e.g.* relating to benthic impact in Australia).
- Codes of practice are becoming widespread and may substitute in part the need for EIA. In Thailand (where EIA is not required) ninety percent of farmers are engaged in a Good Aquaculture Practice (GAP) scheme, and Best Management Practice Initiatives are being developed in India.
- There is a need for more "cluster" level management for small farmers.

Discussion

Scope of application of EIA

There is a new policy for EIA in China since August 2008. A catalogue has been issued, with aquaculture projects being included. EIAs are required for aquaculture in enclosed areas, aquaculture in eutrophic areas, and cage aquaculture. The policy is stronger for marine cage culture.

There is a general issue about EIA for new entrants versus existing farms. Generally EIAs are required for new or expanding farms. How can existing farms be incorporated? What if farms are moved? This highlights the importance of monitoring which can and should be applied to existing farms.

A level playing field for aquaculture and agriculture?

Are EIA requirements for aquaculture more demanding than for other sectors such as fisheries and agriculture? Do other exports coming from Asia have similar demands? How do impacts from aquaculture compare with those from agriculture? It is arguable that they are relatively small. A 1998 study in China showed aquaculture contributed only 5 percent of nutrients compared with a higher figure from agriculture. A new project is undertaking risk assessment of different sectors. This raises the question whether Strategic Environmental Assessment should be undertaken for sector or for area. To ensure fairness and parity, there is a need for common (methodological) guidelines and environmental standards. Life cycle analysis is useful to compare aquaculture against other sectors. Carbon footprint analysis is likely to become the most important common assessment measure.

Risk based approach

Clear thresholds are needed for EIA, and effective monitoring for existing farms or those beyond the accepted threshold. Most thresholds are area or production based. A risk based approach offers an alternative or complement to this. However, is sufficient information available for useful risk analysis? Is there enough local knowledge to define risks and focus? The consensus was that there was for most important issues. Risk assessment has always been part of best practice EIA – it should lie at the heart of screening and scoping – but has not been implemented very well, nor very often. Clearly sophisticated risk assessment cannot usually be done at small project level, but basic risk assessment should always be a key part of the process. It is important also to recognize that risk assessment is not a purely technical exercise – it is often quite subjective, so there is a need for some public/stakeholder participation. Costly sophisticated assessments should be avoided at lower levels. We need a hierarchy of risk assessment – sector level, area level, and farm level. It should get simpler as we get down to farm level, and the higher level assessments should set the frame and scope for lower level assessments. However, administrative authorities are often unwilling to decide/select critical issues at the scoping stage because tend to prefer comprehensive coverage of all issues which may provide a kind of insurance in case something goes wrong.

Industry structure

EIA is affordable to big players and important to producers with export orientation of production. But aquaculture is also important for poverty reduction. There is some consolidation in shrimp farming. Smaller farms are also being forced to consolidate/cooperate and work together in groups. Rationalization is being driven in part by food safety issues. It is possible to do EIA by zones which makes it easier to address the management and compliance (monitoring) for small farmers. This all becomes easier and more effective if it is possible to identify areas suitable for new entrants – i.e. prepare zones for farms and farm clusters. These can be set up with provisions for strategic management by a council of farmers. Assessment and management is much more difficult for existing farms.

Monitoring

In the region, there are some examples of monitoring but mainly in relation to improved management/operational efficiency. There are two kinds of monitoring. EIA typically generates an environmental management plan with specified farm level monitoring requirements. Government may monitor individual (large) farms and/or the wider environment. Monitoring of individual farms as follow up to EIA is not widespread. There is general monitoring in several countries, although this is not clearly related to the EIA process. There are, for example, monitoring networks in China and Viet Nam, but the feedback mechanism to management and response procedures is weak. In China site monitoring is the responsibility of the fisheries department – but is not always followed through. If pollution happens in a fishery area then the fishery department will be involved.

Codes of practice and operating standards

"Soft law" measures such as best practice certification schemes, etc., have proliferated in Asia and standards are beginning to get confused. There is a real need for harmonization.

There would be benefit in harmonizing the national/international schemes or analyzing common criteria between the schemes, and benchmark the different schemes. It is important to ensure equivalence and a level playing field. It is for government to provide a platform/framework and determine minimum standards or benchmarks. These can then be developed further by the private sector – with an eye to what the buyers want.

In the United Kingdom and many other countries large retail chains tend to dictate the standards. Food safety is a major concern/driver. These requirements tend to favour larger producers, but this eventually affects smaller producers. There needs to be a balance between reasonable requirements and the need to keep things simple enough for smaller producers.

In Thailand there is a need for incentives to adhere to Good Aquaculture Practice (GAP). Buyers have particular interests in terms of quality standards, but these need to be balanced also with social standards. Further, foreign markets put pressure on environmental standards but for local markets there is little pressure. The result can be double standards. Now in Thailand shrimp farmers are complaining because standards are high and complex for aquaculture, whereas (for example) vegetable growers are subject to less demanding standards.

Institutions, delegation, coordination

Which takes precedence: EIA legislation or sectoral legislation? There is sometimes tension between sectoral and environmental agencies. It is usually better to implement EIA/monitoring at local level, but this raises capacity issues**.** Clear standards should be established before decentralization. Decentralization and delegation from central to local could involve also delegation from environmental central agency to local fisheries authorities. In all cases coordination between different levels, ministries, authorities etc is important. Capacity building is also of paramount importance, especially where there is decentralization.

In the Philippines there are 900 or more municipalities and the EIA issues are their responsibility. They group municipalities that share a common resource in integrated fisheries and aquaculture management councils. China is now zoning areas at provincial level for specific uses. Large projects are dealt with by the environment ministry and may be subject to EIA. Most small-scale projects, including aquaculture, are dealt with by local level environmental agencies associated with local government.

Institutional responsibilities are also relevant to the implementation of the Polluter Pays Principle. Who pays? The burden will be on the sector – but others may decide. Approaches must be practical, effective and affordable. There is a need for efficient and fair decision processes which effectively tackle problematic or controversial issues - especially where public consultation is used.

GIS

There is little use of satellite imagery and GIS in EIA. It could be better used for regional planning and the identification of zones. It is less useful for project level assessment.

REVIEW OF ENVIRONMENTAL IMPACT ASSESSMENT AND MONITORING OF AQUACULTURE ACTIVITIES IN LATIN AMERICA

Presentation by Alejandro Flores Nava

Mr Flores Nava presented a brief overview of the review paper (see Part 1). Latin America has the highest aquaculture growth rate in the world, with salmon, shrimp and tilapia being the top species, and Chile with the highest production (of which 90 percent is farmed salmon). The main impacts are reported to be mangrove destruction (*e.g.* Ecuador), introduction of exotic species and disease, and algal blooms associated with wastewater from shrimp farms. EIA legislation is mainly based on the US model. Procedures in most countries are quite detailed and look good on paper, but in reality procedures are often not followed. Key recommendations include the need to review standards and norms on a regional basis; to develop sustainability indicators; to establish baselines; to increase capacity and improve the quality and objectivity of information; and to undertake systematic monitoring. Codes of practice and product labelling are also important but there is much room for abuse.

Discussion

Disease

Licensing and quarantine procedures have been developed in Mexico for hatcheries allowing for disease free fingerlings. However, these procedures are not available for fish grow-out in cages. A network of laboratories for disease free fingerlings is coordinated by Mexico's National Commission for Fisheries (CONAPESCA). Quarantines are usually conducted for inland aquaculture.

Introductions and stock movements

All exotic species require EIA by law, especially high valued species for export. However, in practice EIA is not always conducted, especially for those farms that have government clearance/support. In Ecuador, fish and shellfish imports must be referred to a technical committee. However, in Mexico there is much uncontrolled movement across borders between small-scale fish farms. Thousands of live aquatic animals cross the border illegally between Mexico and the United States of America. It was noted that tilapia can be imported as ornamental species which is less strictly regulated. The interactions between aquaculture and fisheries may be positive and/or negative. Stocking of tilapia in many waterbodies in Latin America has had strong positive impacts. Tilapia is being farmed in reservoirs in Brazil where estimates of carrying capacity are being conducted to allow for cage farming development. In general, complex issues of this kind need to be addressed through higher level sectoral or strategic environmental assessment.

Thresholds and triggers for EIA

Although in law small farms need EIA, in practice the normal requirement is simply to have an agricultural soakaway, and a statement that the land does not have agricultural potential. In any case most farms are subject to license conditions, including reporting and random audit by the given environmental protection agency. In practice this is severely resource constrained, and EIA is usually just a piece of paper required to get a license with little if any follow through.

Role of the market

In general, there is no capacity in the region for EIA enforcement, except for aquaculture of high valued species for export. In Ecuador, for example, aquaculture on agricultural lands is not permitted, but many are still doing exactly that. The market is becoming increasingly influential. International trade is putting pressure on exporting countries to do EIAs, but it is important to clarify specifically what kind of pressure this is. For example, US retailer Wal-Mart imposes quite rigorous conditions on salmon suppliers. There is a need to distinguish between the two international trade forces: (1) to comply with public sector regulation, and (2) to see what the effect is of public sector EIA in a context of certification requirements. There is need to compare public sector measures with certification standards/criteria. Public sector initiatives typically have a stronger chance of going through. There are equivalence issues here.

Aquaculture parks

Aquaculture parks (comprising zone, infrastructure, organization) are increasing in Mexico and in Brazil (in Brazil mostly in coastal marine areas) in order to enhance aquaculture growth, facilitate short permit procedures, reduce bureaucracy, and better manage impacts derived from clusters of farms. However, these parks need to be managed properly to prevent farms from creating a "domino effect" when one farm affects a neighbouring farm. While clustering may be good for infrastructure and management, disease and biosecurity can become serious issues, and cumulative impacts may be more concentrated. Responsibility for particular problems is often not clear. And this in turn can undermine management. The concept of aquaculture parks is also important, for example, for the mussel growing areas of Spain – and there are also examples from Asia. Liability is an important issue here –, if the government guides aquaculture into concentrated zones, is the government then responsible for problems that may arise?

REVIEW OF ENVIRONMENTAL IMPACT ASSESSMENT AND MONITORING OF AQUACULTURE ACTIVITIES IN EUROPE AND NORTH AMERICA

Presentation by Richard Corner

Mr Corner made a brief presentation of the Europe and North America review (see Part 1). Some key points made included:

- the need to consider EIA as a process which does not end with the production of an environmental impact statement, but is followed through with monitoring;
- the difficulty of measuring the effectiveness of EIA and monitoring;
- EIA procedures can be very complex and bureaucratic (for example Spain);
- the lack of requirement for aquaculture EIA in some countries (such as the Czech Republic, some states in the United States of America) and the more general lack of any EIA requirement for shellfish culture (except Canada).

Some key recommendations include:

- reduce complexity and numbers of institutions involved;
- make EIA and Best Management Practice complementary rather than overlapping;
- improve the rigour of screening and scoping;
- develop scientifically based environmental quality standards;
- more focused monitoring;
- build trust between farmers and regulators.

Discussion

Diversity of implementation

Environmental management is applied very differently in different countries. Implementation in Greece (monitoring) and Italy (EIA) is rather poor. In Greece there does not appear to be a statutory framework for monitoring, and rather limited implementation of the European Union (EU) EIA Directive. In Italy implementation is devolved and inconsistent. EIA responsibility is at municipality level, with varying levels of implementation or effectiveness. It is possible to get green or red light in adjacent municipalities.

In Spain each of the 16 regional governments has different EIA and monitoring procedures with different parameters, and different monitoring requirements. The process does not take account of social and economic needs. Often local communities, influenced by Nongovernmental Organizations (NGOs) do not want aquaculture, e.g. Galicia's government is under NGO pressure against aquaculture. Accurate unbiased information about aquaculture and impacts of aquaculture is not readily available. Turkey adopted EIA in 1993. In 2003 it specified EIA for fish farms of more than 1 000 tonnes. In 2007 new criteria were agreed for farms located in closed bays, and use of TRIX (trophic status) index is required. In practice all cage farms have been forced to move offshore. The EIA requirements are not necessarily appropriate for fish farming. EIA was previously subject to a size threshold; this is now more complex and depends on currents, depth, distance from shore, etc. Assessment and monitoring of benthos is not required.

There are some countries without major EIA/monitoring requirements (e.g. Czech Republic, Poland) where there is mainly pond aquaculture which is perceived as having little or no impact. The MARAQUA project carried out a useful review of regulatory monitoring requirements in European mariculture. Also a recent EU wide review of implementation of the EIA Directive should be checked. Definitions of EIA used in Europe and North America may not be appropriate to other countries.

Decentralization, decision-making and participation
Recommendations should be for flexible, local, participatory, devolved approaches with the caveat that devolution may be less effective without higher level guidance. There is a dilemma here: decentralization and flexibility are desirable whereas inconsistency and discrepancy are not.

EIA procedures tend to be dominated by a "tick box" mentality, and are often highly subjective. Models can help more rigorous decision-making, as can GIS and multi-criteria decision analysis. Some simple affordable approaches/techniques are available. A GIS based system is being developed in Norway; however such an expensive and data hungry approach cannot be afforded in poor countries.

A key issue is the appropriate degree of participation in decision-making in relation to different parameters or issues. Many are locally important or subjective and need participatory input; others are more technical and can be left to the specialists. If we mix them up we get inefficient participation. Perhaps we need a two stage process: a more focused technical EIA followed by more participatory planning. There is often a lack of trust between farmers and institutions/agencies. Often farmers need to know why they are asked for all the parameters. EIA and monitoring must make sense to the farmer.

REVIEW OF ENVIRONMENTAL IMPACT ASSESSMENT AND MONITORING IN SALMON AQUACULTURE

Presentation by Kenny Black
Mr Black offered a brief overview of the review on EIA in salmon aquaculture (see Part 1). Some key issues raised included:

- the poor response to the questionnaires sent out and therefore the potential for bias;
- the rapid rate of regulatory reform in many countries;
- the near universal application of EIA to large scale salmon farming;
- the existence of well developed monitoring guidelines;
- the historic emphasis on benthic impact;
- lack of follow up and information on the implementation of mitigation;
- the limited connection between EIA and monitoring;
- containment (escapes) as a major current issue;
- the widespread perception by farmers of environmental monitoring as burdensome, costly and over-complicated;

In terms of improvements suggestions included:

- there is a need to examine more carefully what appear to be arbitrary limits on farm size;
- a more consistent approach between countries in terms of the approach to chemical use and regulation;
- the need for more emphasis on cumulative impact, and more work on and application of assimilative and carrying capacity models;
- need for better engagement of stakeholders, especially in the United States of America;
- better public assurance with respect to aquaculture-environment issues;
- more/better use of Strategic Environmental Assessment;
- need for better data on social and economic costs and benefits;

Discussion
Independence of EIA and monitoring
In Scotland fish farm companies often contract their own independent EIA and have in house staff to do much of it. On the one hand the independence of such assessments

may be questioned. On the other hand the farmers themselves are building substantial knowledge and experience, and are subject to stakeholder and government review. Much of the modelling and monitoring is now also done by companies. This allows them to do site optimisation before EIA – *i.e.* they are making informed strategic choices. Nowadays most technical problems (*e.g.* pollution, environmental capacity) are addressed prior to an EIA submission, leaving only social issues and landscape as areas of uncertainty to be addressed in the EIA. However, the public agencies are to ensure quality control.

In Norway farmers do their own voluntary monitoring. However there is a trust issue: farmers are not trusted to carry out their own EIA. Contracted experts are used, and compliance with standards varies. Training in EIA methodology and monitoring is arranged, and there is a list of qualified specialists. It is the role of the Fisheries Directorate to establish standards for EIA conduct, including preparation of a standard template for reporting. The consenting process requires complete records of medicines used (*e.g.* sea lice treatments). In general the use of medicines is well regulated/supervised. There is very little use of antibiotics. To date they do not measure medicine residues in the environment. Sea-lice and the associated chemical use are a big problem in the UK. However, access to chemicals is strictly controlled, and monitoring is done for residues in the environment.

In Chile many companies became specialized in EIA, but government authorities lack the resources to validate if EIAs are accurate. An FAO project is underway to develop an independent validation and certification process.

Public disclosure and transparency

Public disclosure of EIA documents contributes to quality control. In the UK, documents go into the public domain, and NGOs often scrutinize the documents carefully. In Chile the DIA (declaration of environmental impact) is not public, although a full EIA would be. The "environmental declaration" is effectively the same as a basic EIA. However, the full EIA is more comprehensive and includes socio-economic aspects. Certification of compliance is presently done by a non-government institution. It is not clear whether the procedure is effective - most farms report anoxic sediments.

A CASE STUDY: DEVELOPMENT OF PROGRAMMATIC EIAs AND MONITORING PROGRAMMES FOR CLUSTERS OF SMALL-SCALE CAGE FARMERS

Presentation by Patrick White

Mr White presented a summary of work conducted in Bolinao Bay in the Philippines strengthening capacity for environmental management of small-scale cage culture activities (see Part 1). There are currently 9 500 cages generating 120 000 tonnes of fish with little planning and management. The project involved a range of activities including GIS and assessment of carrying capacity, zoning and development of zone committees, cluster level environmental assessment and monitoring, training/awareness, capacity building and institutional strengthening. The purpose of the project was to increase organisation and representation of farmers so that "clusters" of farms could be effectively monitored and managed, and the classic boom and bust cycle of small-scale aquaculture avoided.

Discussion

Monitoring costs

Low cost monitoring, a key issue, can be done, *e.g.* with simple environmental quality tests (*e.g.* using beer cans as sediment grabs) which helps raising awareness and getting the farmers involved.

Disease and biosecurity

The dangers of disease spread within and between clusters were discussed. Biosecurity measures are needed which can be implemented by the zone committee, possibly through bylaws. There is a need for simple good practice guidelines, and for appropriate management measures including the use of higher quality feed pellets.

Management strategy and responsibility.

There is also a management dilemma: is sediment better accumulating in one spot beneath the cages or dispersed through the lake? This will depend in part on the overall capacity of the lake. However, how do you promote individual responsibility? It should be possible to identify which are the worst performing farms, and the worst performing clusters, and then restrict or change production accordingly. What about illegal production? Can this be controlled?

Carrying capacity and strategic relocation of farmers

It seems there are already too many cages according to the calculations of carrying capacity. How can we reduce these and prevent new entry? The rationale for encouraging people away from the areas with high water flow (because this spreads the pollution to other areas and other farms) sounds fine, but this is precisely where most farmers would wish to be: at the best flushed sites. So it will not be easy to move them – irrespective of whether this is desirable or not. In any case location is not just about water quality. They may select a site close to a village or supply base. Over time they will select the best locations based on a range of practical criteria. This is a good example of change management; from an unmanaged to a managed situation where there will be social costs of displacing people. Equally there may be social costs of not moving people (*e.g.* toxic blooms, disease). What were the processes involved in changing habits? What incentives? This should be a major role for the municipality, and for issuing licenses. Capacity building is a key issue here.

GIS

There is a significant resource of high quality GIS data. Where will it reside? How will it be used or shared? This was a project with BFAR/University of the Philippines. There are problems of data sharing between institutions. However the data are already posted on the web.

EIA INFORMATION FROM CODE OF CONDUCT FOR RESPONSIBLE FISHERIES REPORTING FOR AQUACULTURE AND FROM NALOs/NASOs

Presentation by Doris Soto

Every two years a global survey is conducted by FAO relating to the implementation of the Code of Conduct for Responsible Fisheries (CCRF). Ms Soto presented a summary of findings of these surveys, particularly in relation to the use of EIA in aquaculture. The related paper is presented in Part 1. The analysis of survey responses revealed rather limited implementation and effectiveness of EIA in many countries.

Discussion

The workshop participants concluded from the presentation that there are serious issues with the implementation of EIA in many countries. Implementation is very limited for aquaculture and effectiveness questionable. The survey methodology was briefly discussed. The questions posed in the questionnaire and corresponding responses are mainly qualitative rather than quantitative, and quite general. There is no rigorous guidance on how to respond.

EIA is mentioned in the CCRF. Relevant recommendations can be found in CCRF Article 9, in particular in provisions 9.1.2 and 9.1.5:

9.1.2 States should promote responsible development and management of aquaculture, including an advance evaluation of the effects of aquaculture development on genetic diversity and ecosystem integrity, based on the best available scientific information.
9.1.5 States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities.

GLOBAL REVIEW AND SYNTHESIS OF REVIEWS OF EIA AND MONITORING IN AQUACULTURE IN FOUR REGIONS AND FOR SALMON AQUACULTURE

Presentation by John Hambrey

Mr Hambrey provided a brief overview of the main findings and conclusions of the global review and synthesis (see Part 1). The key finding is that while EIA and monitoring is applied to many large scale marine finfish farming and shrimp farming projects, it is not applied to the bulk of global aquaculture production which is dominated by small-scale producers mainly in Asia. Furthermore, it is questionable as to whether farm level EIA could be an appropriate mechanism for environmental management of small-scale aquaculture, since it typically fails to address cumulative impacts. The review also highlights the weakness in many countries in terms of feedback between assessment and monitoring procedures and sector management as a whole. Some key requirements in terms of strengthening procedures were presented.

Discussion

Comparison with agriculture

The potential for learning from agriculture was raised. Has there been benchmarking of aquaculture EIA with other sector's EA? Is EIA applied to agriculture? The view was that while there is usually provision for it in the legislation, it is not generally applied to agriculture except for a few major industrial scale projects, such as major livestock and irrigation schemes. More generally EIA requirements for aquaculture are perhaps more rigorous than for agriculture because of perceptions: fish farms are seen as new and un-natural, whereas agriculture is perceived as "natural", in harmony with nature/landscape *etc.* Chile for example is a country which exports large amounts of fruit. No EIA is required in fruit production. Dairies do have to comply with some environmental regulation, but again no formal EIA is required. Aquaculture is therefore relatively unique in this regard.

The approach used in different countries depends on the relative weight afforded to a sector (agriculture *versus* aquaculture). Agriculture often has much greater weight. There may well be conflicts of resource use also between aquaculture and fisheries. This highlights the need for integrated environmental management in coastal zones. Some sectors are beginning to address environmental management issues through the use of techniques such as environmental economics. Thresholds for requiring EIA are obviously a critical issue which should be further discussed. We also need indicators of the effectiveness of EIA.

Planning and assessment

The participants agreed that we cannot separate out EIA – it is just a part of environmental management. In Norway considerable time has been spent on defining regional goals and objectives. In 1994 environmental objectives were set for each aquaculture area. This helps focus on important issues and better management. These are subject to regular review. Then we can set priorities: undertake risk assessment; rank risks in terms of severity; re-evaluate from time to time – then monitor. Norwegian authorities develop short, medium and long term goals, which are revised every 5 years. The use of Strategic Environmental Assessment may have potential to set the frame and context for EIA, but may be too broad. The key is to agree the environmental objectives.

In Spain there is a new example of the use of strategic environmental assessment in Galicia in relation to turbot aquaculture and the development of a coastal zone plan. Aquaparks are required to submit an overall "Park" EIA. EIA for an individual farm then becomes much simpler. In many countries there is a general tendency to seek to drive fish farms "off shore" to reduce planning conflicts.

Institutions

There is a clear distinction between environment agency driven EIAs, and sector driven EIA, and some participants expressed the view that the latter is better. For example there has been a move to give greater responsibility for environmental management to the fisheries department in Viet Nam. This department is better placed, and better resourced to meet the task, and better able to implement longer term management interventions.

The issue as to whether a clear recommendation should be offered on this was discussed, but there was no clear consensus. Much depends on the specific nature and capacity of the institutions in different countries; funding mechanisms; the scale at which intervention is appropriate – and the institutions that correspond to that scale. The latter is of particular importance if we are to implement the ecosystem approach to aquaculture where scale of management is a crucial issue. In some cases an environment ministry, department or agency may be better placed to do the job; in others the fisheries department. The key is to get the procedures right, and ensure that the skills and knowledge of all relevant institutions are drawn on.

Working groups and structured discussions

Michael Phillips (chair) introduced the tasks for this Session: an initial discussion of priority issues which the workshop could usefully discuss; followed by three break-out groups to deal with sets of related issues. The overall aim is to come up with key findings and recommendations in relation to these issues.

PRIORITY ISSUES FOR DISCUSSION

John Hambrey (facilitator) introduced the discussion guide prepared for the workshop (Annex 4), and some of the key issues identified there. Michael Phillips (chair) then solicited views from all participants on what they considered to be the key issues, bearing in mind those identified in the discussion guide. The points raised during the discussion were rationalised and grouped into the following three major categories to serve as a starter and framework for the deliberations of the three working groups. Some important cross cutting issues (*italics*) are included in more than one category. The three major categories identified are:

i) Management framework
ii) EIA procedure and practice
iii) Monitoring

BREAK OUT GROUPS

Participants were divided into three working groups (corresponding to each of the three categories) to discuss the relative importance of these and other issues and to prepare preliminary findings and recommendations. The three working groups provided their discussion outputs to the facilitator for consolidation and organization, and presentation to plenary for final discussion and agreement.

MANAGEMENT FRAMEWORK

Working group (1) focused on the following issues:

1. Joining up the components: making the environmental management system work.
2. Frameworks for applying concepts of sustainable development and management.
3. Strategic Environmental Assessment: potential and role.
4. More clarity on meaning and relationships between EIA, SEA, ecosystem approach.
5. Relationship between EIA, monitoring and integrated management plans.
6. Issues which alternative management tools (EIA, SEA, Codes of Practice, regulation, *etc.*) best able to address, *e.g.* how best to deal with alien species?
7. Decision-making and institutional framework.
8. Role and impact of aquaculture in the wider environment.
9. Best Management Practice (BMP) and EIA. Which works best for what?
10. Relationship with/use of ISO 14001
11. Developed and developing countries. Big farms and cluster management?
12. Inclusion of small farmers.
13. Refining focus and addressing priorities.
14. Simplifying procedures.

15. ISO 4001.
16. Dealing with species introductions.
17. Capacity building.
18. Farmer awareness/understanding/communication.
19. Need for/use of objectives and standards.
20. Linkage between EIA and monitoring.
21. Feedback mechanisms (assessment-monitoring-management).

EIA PROCEDURE AND PRACTICE

Working group (2) focused on the following issues:

1. Definition of EIA – do we usually have it but don't call it EIA? A suite of related procedures?
2. Are we "hung up" on EIA? A step to get a permit? Or something more?
3. EIA and the ecosystem approach.
4. Defining the scope and focus of EIA:
   a. Prioritisation, risk analysis;
   b. Avoiding duplication with other management tools.
5. Who should be the competent authority, coordinating authority?
6. Addressing social and economic issues – the roles of science and/or participation.
7. The use and value of tools – communication, visualisation, GIS, modelling, socio-economic *etc.*
8. Implications for extractive versus assimilative production systems (*e.g.* molluscs *versus* carnivorous finfish?).
9. The special features of aquaculture – what they are and how to take account.
10. Implementation of environmental management plans.
11. Coordination and integration, especially with respect to inputs/response to the EIA process.
12. Increased inclusion – how can/should EIA/monitoring be applied to small farmers?
13. Public disclosure and information sharing – EIA reports – data.
14. Refining focus and addressing priorities.
15. Capacity building.
16. Farmer awareness/understanding/communication.
17. Need for/use of objectives and standards.
18. Linkage between EIA and monitoring.
19. Feedback mechanisms (assessment-monitoring-management).

MONITORING

Working group (3) focused on the following issues:

1. Simple, practical monitoring regimes.
2. Defining the scope and focus of monitoring – risk analysis.
3. Human resources, capacity, costs, levels of detail.
4. Inclusion of social and economic issues?
5. Tools – communication/visualisation; socio-economic; GIS
6. Approaches to dealing with seasonality and complexity.
7. Environmental performance indicators.
8. Eco-efficiency benchmarking; socio-economic monitoring – how to feed into policy and practice.
9. Integration of socio-economic and governance aspects and targets.
10. Ecological baselines.
11. Use of sustainability indicators.
12. Public disclosure.

13. Refining focus and addressing priorities.
14. Capacity building.
15. Farmer awareness/understanding/communication.
16. Linkage between EIA and monitoring.
17. Feedback mechanisms (assessment-monitoring-management).

Presentation and discussion of key findings, recommendations and guiding principles

The facilitator, John Hambrey, integrated and rationalised the findings of the three working groups. During a plenary session opportunity was given to all participants to comment on, discuss and refine these findings and recommendations. The chairman, Michael Phillips, emphasised the need to focus on effectiveness and practicality.

The output of this session, which was developed mainly on-screen in direct response to the discussions, is presented below. Notes of the separate working groups have been added where relevant, and where they support the recommendations agreed in the plenary. The following findings and recommendations are grouped here into five main areas including (i) diversity; (ii) management framework; (iii) EIA procedure and practice; (iv) monitoring and (v) capacity building.

DIVERSITY

All participants agreed that the practical and effective implementation of EIA and monitoring must take account of the huge diversity of both aquaculture, and local geographic, social and economic conditions.

- Environmental management needs for aquaculture vary greatly throughout the world.
- Government response – in terms of the application, scope and detail of EIA and monitoring – should be proportionate to the level of environmental risk associated with aquaculture.
- Recommendations should be interpreted and applied according to national and local needs.

A MANAGEMENT FRAMEWORK OR "SYSTEM"

- EIA and monitoring requirements and procedures cannot be defined in isolation. They should be seen as tools or elements in a broader environmental management framework or system.
- This framework should comprise elements which apply at global, regional, national, watershed and farm cluster or farm level. Figure 1 and Table 1 show some of the tools and approaches that can be usefully applied at different levels.
- Monitoring can be conducted even without EIA and is an essential management tool; EIA on the other hand should be used in particular situations, *e.g.* large-scale projects, or high risk conditions, but is of little value if conducted without monitoring.

Key elements required in an effective environmental management system

The participants recognized a number of key elements which are important for an effective environmental management system for aquaculture (Figure 1; Table 1).

- Nested and coordinated regional, national and watershed aquaculture development and management strategies. Scales should be pragmatic though ideally national; watershed; local. The latter may be specially defined for purposes of aquaculture management, or related to existing governance boundaries. These are discussed in more detail below.

- Clear objectives, standards, and decision criteria – including reference points – appropriate to the level or scale.
- Licensing or permitting procedures, and associated environmental assessment (detail proportionate to level of risk)
- EMP/CoP/BMP relating to farm operation. Reinforced where possible through market mechanisms and/or the EIA-permitting process.
- Monitoring of farms: implementation of EMP/CoP/BMP; local environment; wider environment
- Feedback and adjustment mechanisms - assessment of effectiveness of strategies, standards and permitting procedures as required at all levels.

EIA as such may be more or less important depending on the nature of aquaculture. Typically it is only a useful tool for large scale aquaculture, or those developments with high environmental risk. There is a range of ways these various elements can be applied and brought together at different geographic and administrative levels. The following diagram and table illustrate some of the possible relationships.

A strategic hierarchy

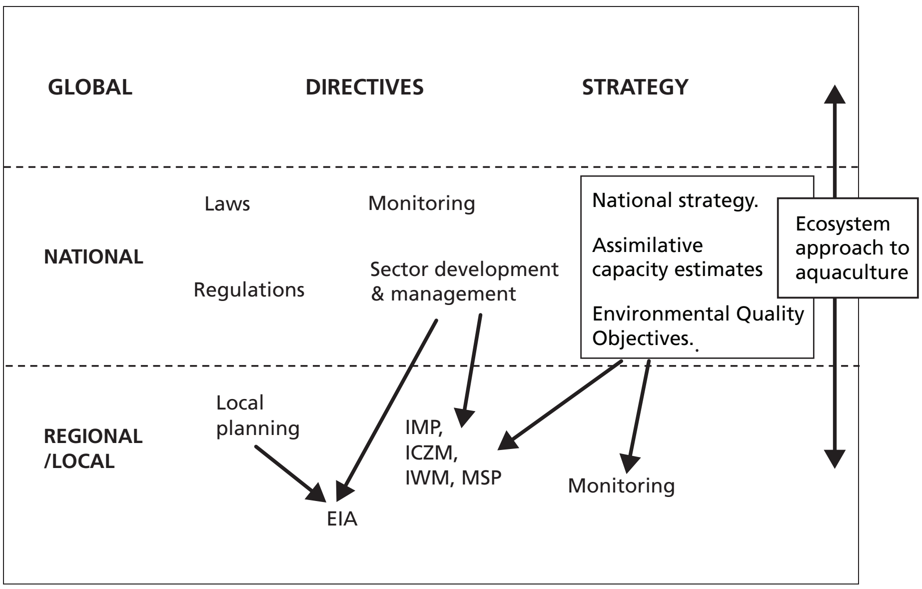
The workshop identified different scales and related levels of strategy (Figure 1; Table 1).

(1) National strategy

A key requirement is for a national aquaculture strategy, which would set out the mechanisms for support and management of the sector at national level, and provide a framework and guidance for mechanisms that should be applied at regional or local levels. The strategy should include the following:

- Clear purpose and objectives. The goal of any national strategy and subsidiary management measures is likely to be sustainable development.
- Nationally appropriate definitions of EIA, SEA, *etc*
- Relationship with legal framework.
- Requirements for lower level management units – ecosystem/watershed level; local management level (eco or governance units - *e.g.* Bolinao Bay; local authority); farm zones or clusters.

FIGURE 1
Elements in a hierarchical management system



IMP: Integrated management plan; ICZM: Integrated coastal zone management; IWM: Integrated watershed management; MSP: Marine spatial planning.

TABLE 1
Applicability of different management mechanisms at different scales

	Global	Regional*	National	Local	large farm	small farm or cluster
Strategy	Rio, EAA,EAF	X	X	X		
Planning		ICZM	ICZM	zoning	farm site	
Risk analysis		X	X	X	X	
SEA		X	X	X		
Local plan				X		
EIA					X	
Environmental declaration						X
Permit/license					X	X
Monitoring			X	X	X	X
Control				X	X	X
BMP/CoP					X	X
Certification	X	X	X	X	X	X

* Could also include international waters/watersheds.
EAA: Ecosystem approach to aquaculture; EAF: Ecosystem approach to fisheries; ICZM: Integrated coastal zone management; SEA: Strategic environmental assessment; BMP/CoP: Best management practices / Code of practice

- Analysis and screening of national threats/opportunities (*e.g.* exotic species, pollution, disease, food security, *etc*).
- Priority issues and associated objectives, standards, and where possible reference values. May need both process and outcome indicators.
- Screening guidelines (*e.g.* priorities for simple risk assessment) for EIA or other management controls.
- Tools and mechanisms with which to address priority management issues.
- Definition of appropriate ecological management units.
- Monitoring procedures to address national level threats and risks, and framework/guidance for local monitoring.
- Links and coordination mechanisms between levels of assessment, individual EIA and monitoring.
- Support measures for smaller farmers/clusters/zones.
- Responsibilities (*e.g.* fisheries department, environment agency; local authority) for different functions: permitting, decision-making, monitoring, planning *etc.*
- Consultation and delegation procedures.
- Coordination of permitting procedures, operational regulation/control, voluntary codes, market incentives.

The group also discussed the desirability or otherwise of identifying particular "high risk" aquaculture systems or technologies. There were different perspectives on this. Some considered that the key was to manage the risks (such as pollution, escapes) and allow the private sector to use their own initiative to meet corresponding standards – using whatever technology they wished. Others thought it appropriate to specifically identify low risk (*e.g.* integrated multi-trophic aquaculture) and high risk (intensive monoculture) technologies.

(2) Strategies for waterbodies, integrated coastal zone or watershed management

The scale at which these strategies should be developed is not easily defined, but should take into account ecological systems and their connections, physical and "natural" boundaries, the spatial distribution of aquaculture activity, social structures, and administrative boundaries. The key here is to define and manage a "common resource".

Broadly speaking these strategies would have similar elements to those listed above for national strategies, but more highly specified and appropriate to local conditions. Additional elements might include, for example:

- A clear strategy about the place of aquaculture, its relationship with other sectors, and its use of resources (including areas/water, *etc.*)

- Carrying capacity (many dimensions) or maximum allowable capacity, and current status in relation to these, should be estimated and agreed by stakeholders (with proper scientific information).
- Co-management agreements over transboundary waterbodies (agreed management structures between neighbouring States) to foster sustainable aquaculture.
- Coastal/watershed planning and zoning should consider allocation of farmers licenses (rights) contingent upon compliance with environmental standards and requirements.

(3) Local management plan/cluster management plan/area management plan

Again the scale at which these may be developed will depend on a variety of factors including the nature and spatial distribution of aquaculture activity; the physical characteristics of the watershed/waterbody; the nature of important management issues; and the local governance structures. There are many examples of these from throughout the world, including local authority master plans or framework plans; area management agreements (e.g. to address the problems of sealice in Scotland); plans for particular zones (e.g. Philippines case study; marine management plans in New Zealand, etc.). These plans may be sectoral, or preferably nested within an integrated management plan covering all resources or users.

(4) Farm level

A new development should be subject to:

- a permitting or licensing procedure;
- screening and scoping;
- EIA if designated as high risk;
- simple environmental assessments or statements for smaller farms or low risk activities;
- monitoring related to local threats and risk levels.

If EIA is not required, there should be a clear higher level management/regulatory framework which might include for example Code of Practice/Best Management Practice and/or specific regulations, consents and monitoring which would apply to all new and existing development as appropriate. The way in which the various tools and mechanisms can be deployed most effectively should be a key consideration in the national strategy.

Role of Codes of Conduct, BMPs, *etc.* in a management system

These are of particular importance to manage existing and small-scale aquaculture, and may be complimentary with, or an alternative to, EIA. For some farmers adherence to CoC may be a precondition for a production licence or permit, and may be required to access important markets. The following actions may be considered:

- Design codes of practice and regulations and EIA approaches so that they are complementary and don't overlap to avoid duplication and unnecessary costs.
- Promote Code of Conduct (CoC) to reduce burden of EIA completion/ implementation
- (e.g. capacity building/training on CoC can assist in EIA adoption/ implementation;
- staff can be certified to ISO standard).

A risk based approach (regional, watershed, local)

Adequate assessment and communication of risks can be very useful for environmental management purposes.

- Risk assessments should define the application and scope of different levels of environmental assessment (SEA, farm EIA).

- Risks should be evaluated and prioritized through sound science based technical *and* participatory consultation process.
- There should be periodic review of risks.

Feedback and communication tools

There is a need for feedback mechanisms at all levels to ensure that environmental management responds to identified needs and steadily improves in terms of both focus and effectiveness. This relates partly to procedures and institutions, and should be spelled out in relevant strategies. It is also dependent on effective communication, especially between scientists, authorities, farmers and other stakeholders. Possible methods include:

- Extension work, workshops, seminars, training.
- GIS, internet, manuals, email newsletters, SMS (telephone).

It may be possible to address emerging environmental issues through better use of existing technology or through new technology. It is also important that monitoring and learning that takes place at farm or local level feeds back into national strategy.

Coordination and integration

A lack of coordination and integration is highlighted for many countries in the review papers. This lack of integration in some cases causes unnecessary delays in *e.g.* licensing or permitting procedures. Integration can be improved in several ways, for example:

- Institutional mechanisms to better integrate the departments involved in the process of aquaculture licensing (*e.g.* one stop offices where appropriate could facilitate/streamline licensing).
- Working task groups or council could be created to better coordinate activities.
- Relevant databases and information systems following agreed standards and methodologies are needed to enhance coordination, integration and consistency.
- Need for expert advice on different datasets/information (*e.g.* feedback from specialists such as GIS analysts, economists, modellers, *etc.*).
- Need to coordinate with international organizations and their agenda/guidance.

EIA PROCEDURE

EIA is a decision support tool which may apply to the permitting procedures for new aquaculture development. It was originally conceived as applying to major significant individual developments, and this remains its most effective area of application.

Definitions for EIA and SEA

A clear definition is a priority for EIA implementation. However, the process is different in each country. It is therefore appropriate to propose a global EIA definition (see box, for an example), and then prepare a specific definition of EIA for aquaculture in each country. Such a definition should however be consistent with those for other sectors.

It may be appropriate to refine EIA definitions according to species, culture systems, practices, scales and geography. An EIA definition should support implementation of an environmental management system for aquaculture. It should not allow for an interpretation as a one-off event designed to secure a piece of paper. Socio-economic aspects should be included in the EIA definition where these are not addressed in parallel permitting procedures.

In practice many different procedures, ranging from relatively simple “environmental declarations” to major research and public consultation exercises, may be referred

> **EIA definition**
>
> “The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made”
>
> International Association for Impact Assessment, 1999.

to as EIA. Particular requirements will depend on all the other elements in the management system, and should be defined at national level.

Strategic environmental assessment (SEA) has been given a range of definitions in different countries/regions. In general terms it may be defined as *any* form of higher level environmental assessment - applied to a sector, programme, area, or ecosystem (*e.g.* as part of ICZM, national strategy, etc).

A context for EIA

- EIAs should always be informed by higher level policy and strategy, and reinforced/improved through monitoring as described above.

Screening and application

- EIA should only be applied to aquaculture development that represents a high risk. This may be defined on the basis of scale, technology, production, sensitive habitat, other users, *etc.* Risk analysis should support all such decisions.

Scope and focus

- The scope could be improved by
  - better defining objectives of EIA using national guidance (*e.g.* defining parameters) or a through specific legislation
  - setting priorities taking account of higher level analyses
  - conducting risk analysis taking account of higher level analyses
- Focus can be refined by avoiding duplication with other management systems (permits, licenses, planning) which already deal with specific environmental threats through generic measures;
- Focus should be on priority environmental threats *and* socio-economic values (where these are not already addressed through other mechanisms). In some countries a business plan is required as part of an EIA submission in order to ensure economic sustainability

In general EIA needs to be streamlined and simplified as much as possible.

Competent authority

It is important that there is a designated competent authority with responsibility for EIA of aquaculture. There are advantages and disadvantages for a fisheries department or environment agency having responsibility for EIA of aquaculture. Coordination and decision-making by a fisheries department may lead to more streamlined, predictable and better informed EIA, and more effective follow up in terms of implementation and monitoring. However, there is a danger of pro-sector bias. Either way, both should be involved, bringing together the neutrality and environmental expertise of the environment agency, and the technical knowledge of the fisheries department. In any case, responsibility for appraisal of EIA documents may be different from the overall management of the EIA process. EIA can also be appraised at different levels.

Delegation and decentralisation of responsibility is also an issue. Broadly speaking decentralisation is desirable, but there may be limited capacity at local level. These are both important issues to be addressed in the national aquaculture strategy. The main point is to make responsibilities clear, and ensure adequate financial resources and capacity to do the job effectively and without conflict of interest.

Public participation and peer review

Public participation is widely regarded as a key element of EIA.

- Public participation provides an important perspective, particularly on social and economic issues.

- There is a need for better strategies to allow for inclusion of public opinion.
- Public or third party participation, as well as technical peer review are essential for quality control of EIA.
- Public or third party audits of management initiatives developed jointly by industry and sectoral agencies also serve as quality control.

Tools

There are many tools that can be used to support more effective EIA. There was much discussion about their value and effectiveness, with a range of opinion expressed, and a general feeling that more discussion was required. The following were the main agreed points:

- Predictive models can reduce data needs.
- More tools and/or enhancements to existing tools are needed, *e.g.* communication, visualization.
- Tools to estimate environmental capacity are particularly important – and can be quite simple for some situations.
- Models are needed to better understand ecosystems (*e.g.* hydrology).
- Models may need to be species specific.
- Sharing of information between agencies/sectors involved in EIA process needs to be improved.
- Background (baseline?) data collection methods should be improved

There is an important question as to whether some of the models enhance or hinder communication and participation. This re-emphasises the need for better visualisation and communication tools.

General mitigation

- EIA should generate a farm level environmental management plan (EMP)
- Mitigation is a key part of EIA procedure and follow-up, and mitigation requirements may be defined at various levels
- Mitigating adverse interactions between fisheries and aquaculture is important.

Public disclosure

- Public disclosure of EIA data/information/results should be mandatory, except possibly in the case of sensitive commercial information
- Relevant/EIA information should be clear and should be disseminated in a timely fashion.
- Findings resulting from environmental monitoring should also be disclosed.
- Appropriate dissemination mechanisms should be developed.

Inclusion of small-scale farmers

It is noted in almost all the review papers that small farmers are usually excluded from the EIA process because many small-scale farming systems are considered as individually having insignificant environmental impacts. Although this is rational, there is a need to include small farmers more effectively in the environmental management process. This might be achieved in several ways:

- Official definition/recognition of small farmers, and identification of environmental management measures appropriate to them.
- Zoning (*e.g.* aquaculture parks/areas) could allow for increased participation of small farmers.
- Adoption of appropriate codes of conduct and incentives.
- Support by public authorities to small farmers to help them report on or monitor environmental conditions.

Links between EIA and monitoring

EIA usually generates an environmental management plan (EMP) – either directly as part of the EIA preparation, or subsequently as required by permiting authorities and informed by the EIA. The Environmental Management Plan arising from an EIA should include:

- What is going to be monitored according to risks and scales (farm, local, regional)
- How the monitoring will be incorporated in adaptive management (both at the farm level and for the wider environment).

Environmental monitoring is often weak and can be improved in a variety of ways as discussed below.

Incentives

Market mechanisms may be used to promote use of and compliance with EIA, monitoring and other management mechanisms.

MONITORING: "TOWARDS SIMPLE PRACTICAL (AND TECHNICALLY SOUND) MONITORING REGIMES"

The purpose of environmental monitoring is to determine environmental conditions and ensure that environmental impacts remain within acceptable agreed limits (environmental quality objectives/standards) as specified by the EIA, and at the same time to improve the conditions of production on aquaculture farms.

Monitoring of aquaculture development is an essential part of its management and should be an integral part of any aquaculture management plan. Monitoring associated with EIA is often not carried out in practice. Monitoring may be required by law and/or certification schemes.

Levels and types of monitoring

There may be several levels of monitoring, depending on the species, technology, or context:

- on farm (done by farmers);
- around the farm;
- among several farms;
- clusters of farms;
- strategic monitoring which addresses ecosystem level issues which might be at waterbody level or for a larger area (*e.g.* to monitor cumulative effects, disease, alien species, *etc.*).

The authority in charge of the "ecosystem level" should be defined at the national level (through legislation or national strategy), but the authority should remain at the lowest relevant scale.

All monitoring should be proportionate to risk and scale.

Standards and indicators

Appropriate indicators and standards should be chosen for evaluating the performance of aquaculture at different levels.

- Need agreed and practical environmental quality standards (EQS).
- Set up proper standards and indicators according to the culture system and identified impact;
- Indicators can be identified for the different levels identified above.

Indicators or standards may relate to maximum allowable change in the aquaculture areas; or they may relate more directly to the proper implementation of a management tool.

Authorities have an important role to disseminate advice on the availability and generation of baseline data. Ideally baseline environmental information should be available for a given environment in situations with no aquaculture development. Monitoring data would typically include similar areas with and without aquaculture (reference data).

Application

- Monitoring is more important than EIA. EIA without monitoring has limited value only.
- Monitoring should be done irrespective of whether or not EIA is undertaken or an EMP is in place (most aquaculture globally is not currently subject to EIA).
- Monitoring is important in relation to follow-through of EIA recommendations and EMPs, and provides important feedback to determine the impact of the development.

Simplification and consistency

- Monitoring is costly especially for small farmers, and must be made cost effective.
- There is need to greatly simplify requirements and practices of environmental monitoring in aquaculture, in order to facilitate its application and effectiveness more widely, so that it becomes a regular practice and an accepted practical management tool.
- Comparable standards should be applied so as not to burden aquaculture producers with varied complex and often contradictory standards.

Monitoring programmes

Monitoring should always take place in the context of a well managed programme, including the following elements:

- Objectives
- Parameters - minimal number
- Methods and procedures (including flow chart)
- Information management
- Responsibilities
- Authority for corrective measures (*e.g.* limits on medicine use)

Defining the scope and focus of monitoring: risk analysis

Many monitoring programmes are ambitious, expensive, and ineffective. It is essential to focus on the most important parameters which a) are sensitive to specific threats and b) good indicators of environmental health more generally.

- Risk analysis should be used at all levels (national to farm level) to identify monitoring priorities.
- Government authorities can provide a general framework and priority setting for overall monitoring requirements (*e.g.* in a national strategy).
- Strategic environmental assessments on larger area scales (including local / regional ecosystems) could provide information on high priority risks to be monitored in specific waterbodies.
- Monitoring should relate directly to management priorities and objectives.

Monitoring for small-scale aquaculture

"... common waterbodies need common thinking and joint action..."

Most aquaculture is still small-scale, so it is particularly important to develop monitoring which can be applied cost effectively to large numbers of small farmers:

- Government authorities should provide support to local communities/users groups area for waterbody management: organisation, facilitation, communication;
- Extension services may advise and assist with monitoring for individual farmers or farmer groups;
- Licenses should be linked to site specific monitoring, and implementation assured;
- Authorities may identify and encourage responsible and trustworthy advisors who may serve in dissemination of good environmental management practices, including monitoring.

Some participants had significant reservations about the last of these points. Suppliers may have a vested interest in high use of inputs which may not be in the interests of the wider environment or country at large. On the other hand these suppliers typically have highly effective links with many farmers and therefore offer an important opportunity to deliver messages and assimilate information from the field.

The need for communication of benefits of environmental monitoring

All working groups emphasised the need to engage farmers in assessment and monitoring for their own benefit as well as for others. Monitoring is:

- for farmers to improve performance and production; and to serve as early warning system on environmental and health conditions;
- for other local users, in order not to affect other commercial operations and living/livelihood conditions, or the use of local valuable habitats and resources;
- for consumers to be satisfied that utmost care is being taken to provide the highest possible quality product;
- for governments/authorities; to safeguard development of the industry and the environment as a whole; to help support decision-making and strategic environmental management.

Ideally, monitoring should be a partnership activity for both government and the private sector, with shared benefits arising.

Institutions and responsibilities

- The supervision (control/coordination/surveillance) of environmental monitoring should be the responsibility of one authority.
- The costs of environmental monitoring may be shared between individual farmers; between producers and government; among producers (organizations); between producers and other local users;
- Larger producers can play a major role in monitoring;
- Information management requires more attention.

Feedback

Mechanisms must be in place to ensure that monitoring data are analysed and the results used to adjust management at all levels (national to farm level) to ensure environmental objectives are met.

CAPACITY BUILDING

Capacity building was addressed by all three breakout groups, and the conclusions and recommendations have been rationalised and brought together in this section.

Capacity building is a key area to promote improved environmental management and is not just about professionals. Indeed all working groups emphasised the need to increase awareness, understanding and involvement of farmers – through better communication, dissemination, and extension. Equally, professionals need to better understand farmers and aquaculture. Better communication is required in both directions.

It is important also to come back to the issue of diversity. Capacity building needs will be tailored to the particular needs of different systems, environments, and people. Notwithstanding this, some general points can be made:

- Raise awareness of the nature of EIA, monitoring, and environmental management more generally.
- Improve governance to encourage participation of stakeholders.
- Devolve responsibility as far as is practical, ensuring consistency with higher level strategy.
- Support and strengthen farmer organisations (especially for small farmers – where possible in functional clusters), and give them incentives and responsibilities. Clear allocation of rights and responsibilities should in itself lead to increased capacity.
- Simple and practical manuals, guides, toolkits and training programmes on environmental management of aquaculture generally, EIA and monitoring should be developed and disseminated. These should draw on and strengthen existing knowledge and experience of aquaculture practitioners, many of whom have their own "informal" assessment and monitoring.
- Support (technical, financial, equipment, *etc.*) is needed to enhance capacity of local authorities in extension of good aquaculture practices, including regular on-farm, simple and practical environmental monitoring.
- Upgrade awareness, technical competencies and skills of producers, local authorities, extension workers, EIA advisors/consultants - on the selection and use of most important and simple environmental monitoring parameters and methods.
- Clarify and strengthen the role of those authorities supervising and deciding on environmental monitoring schemes and data, as conducted around individual aquaculture farms, farm clusters and aquaculture parks.
- Strengthen decision-making procedures, informed by sound science on the one hand, and efficient and balanced participation of stakeholders on the other.
- Ensure quality assurance of EIA and monitoring procedures.
- Promote better management, analysis, sharing and communication of important data and information relating to environmental management.

Some key messages

At the final workshop session Michael Phillips (chair) solicited participants to offer what they considered to be some key messages of this workshop. The responses have been grouped into similar or related messages or principles and rationalised where appropriate. There is no prioritisation.

Awareness

- Governments should take care of the image of aquaculture; recognize the positive aspects of aquaculture; recognise that it is not a major threat.
- Increase awareness of EIA and monitoring; get farmers more involved; increase responsibility of farmers; strengthen institutions.
- Change the way people think about EIA. EIA/monitoring should be seen as providing opportunities to improve sustainability.
- Recognize producer needs and their context.
- There is a need for practical guidelines and use of relevant tools for environmental assessment and monitoring in support of sustainable aquaculture.

Institutions, decision-making and capacity building

- Strengthen capacity of governance structures for aquaculture.
- Develop national aquaculture strategies to define an appropriate management framework for aquaculture appropriate to the particular conditions and nature of aquaculture in each country.
- Strengthen institutions and improve coordination between them.
- Clarify responsibility for EIA and monitoring.

The central role of monitoring

- Environmental *monitoring* is the most important requirement. This should apply to the entire management process and the wider environment. Governments need to engage actors and institutions at different levels to facilitate good monitoring, to ensure that the right management systems are working in the right place.
- Scientifically robust monitoring of environmental risks, with timely feedback to farm management - for both farmers and regulators.
- Monitoring should be made more effective, and procedures more integrated between departments/sectors /organisations.

Role and purpose of EIA

- There is a need to clarify the purpose and need for EIA
- EIA should be perceived as a tool for regulators to support the development of the aquaculture sector in the context of integrated area (coastal zone; watershed area) planning and management, and for the private sector to sustainably operate a commercial enterprise where public resources are used.
- EIA is largely ineffective and meaningless without a ‘monitoring’ programme.
- EIA can be used for management processes providing planning, monitoring and corrective measures.
- EIA is a useful tool for decision support and information generation.
- Focus on EIA as one tool - as a means of promoting sustainability. While EIA is a tool, monitoring is an essential process.
- EIA and monitoring should be informed by risk analysis.

Simplification, relevance, focus, efficiency

- Many EIA and monitoring procedures are too complex for less developed countries.
- Simplify the EIA process; focus on the real risks to make it more relevant; speed up decision-making processes; ensure procedures are in the hands of the most competent authority

Information

- Use EIA FTP sites as a valuable source of information for decision-makers working in institutions/governments, to help them better understand/prioritize activities/funds for EIA and monitoring.
- Promote a global framework for EIA aquaculture, with supporting guidelines.
- Institutional coordination in the delivery of EIA and monitoring is vital.
- Efforts should be made to formulate strategies to collect best quality information for resource poor countries.

Wider management issues

- Identify suitable zones for aquaculture and associated management needs

Dissemination of findings

The final workshop session also comprised a discussion of how to disseminate important findings and messages.

- There are important opportunities to develop web-based regional databases, and bring these together with resources such as "ECASA" (http://www.ecasa.org.uk/).
- There is a need for concise guidelines outlining key steps for environmental management of aquaculture. Materials should be specifically developed for non-technical people operating at the local levels (local government units);.
- The advantages and disadvantages of "cluster development" need to be more widely disseminated.
- There is a need for guidance and training on aquaculture information management systems (Thailand offers a current example of a project to address this).
- There should be an easily translated executive summary of all this work.
- A group of practical leaflets showing the different procedures and stages for EIA (*e.g.* "Scoping") would be useful to authorities, producers, and other interested parties.
- Regional Fishery and Aquaculture Bodies, where these exist may be a very good route through which to provide information and advice.
- Do we need EIA guidelines? Opportunities exist for developing guidelines, to clarify some issues, facts, terms and procedures for aquaculture purposes, although generalized guidelines on EIA do exist. However, the issue is not EIA only, there may be need for institutional reform and recognition of stakeholders. Capacity building is important.
- Legal recognition of the specific characteristics and needs of the sector would drive and focus demand for better advice.
- A key message to get across in any documentation is that EIA should not be a piece of paper allowing development, but rather one tool within an effective environmental management system

Closing

The workshop was completed with a discussion about finalisation of project outputs. Key points raised were:

- The need to ensure accuracy and consistency of bibliography;
- The need to finalise the global synthesis report and discussion guide;
- The incorporation of the Bolinao Bay Case Study into the technical report;
- The need for a *caveat* that details of legislation in the review reports may be out of date in some cases;
- The need to make cross reference to the parallel work on the "ecosystem approach to aquaculture".

Deadlines for the submission and finalisation of various products were then discussed and agreed. Thanks to all parties were expressed for the exceptional hard work that had gone into preparation of the review and synthesis documents and the running of the workshop.

ANNEX 1

PROSPECTUS AND WORKSHOP AGENDA

FAO Technical Workshop on
Environmental Impact Assessment and Monitoring in Aquaculture
15-17 September 2008, Rome, FAO Headquarters

PROSPECTUS

Background and Scope[1]

"Environmental Impact Assessment and Monitoring in Aquaculture" is one component of the FAO project "Towards sustainable aquaculture: Selected issues and guidelines", (GCP/INT/936/JPN), which is being implemented by FIMA, FAO's Aquaculture Management Service, with the generous support of the Government of Japan.

The Project Component on Environmental Impact Assessment and Monitoring in Aquaculture aims to address key issues of environmental assessment and monitoring in aquaculture with view to generate strategic advice and technical guidance information for use in policy-making, capacity-building and training in the sector. Special attention is given to different aquaculture farming systems, different environments and different socio-economic contexts of development, with particular consideration of special circumstances and requirements of developing countries. The immediate objective of this Project Component is: ***To develop of a global overview, including comparison and synthesis, of existing procedures and methodologies of environmental impact assessment and monitoring in aquaculture.***

This Project Component covers two main activities:

- Compilation, review and synthesis (based on desk studies) of existing EIA and monitoring procedures and practices in aquaculture
- Identification - through scoping/ranking case studies and a technical seminar - of environmental assessment approaches and methodologies most suitable to different production systems, commodities and environments.

This Project Component facilitated the preparation of five studies. Four **Regional Case Studies** were prepared to cover the compilation and review of existing EIA and environmental monitoring procedures and practices in aquaculture in selected countries of the following four Composite Regions.

Africa:	Egypt, Nigeria, Mozambique, South Africa, Uganda, (others: Madagascar, United Republic of Tanzania, Zambia);
Asia-Pacific:	Australia, China, India, Indonesia, Japan, Malaysia, Philippines, Thailand, Viet Nam (others: Bangladesh, Sri Lanka, Republic of Korea)
Europe/NorthAmerica:	Czech Republic, France, Greece, Hungary, Italy, Netherlands, Poland, Spain, Turkey, UK, and Canada/United States of America
Latin America:	Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico

A **Fifth Special Case Study** focused on EIA in cage aquaculture of salmon in Canada, Chile, New Zealand, Norway and UK. A global review and synthesis report is being prepared based on these four regional case studies and the special salmon cage aquaculture study.

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[1] This prospectus is distributed together with the TORs for the 5 case studies for background / reference on the scope of this workshop.

The workshop will provide the opportunity to present and discuss the five case studies and the global review synthesis report, and, based on experiences and findings by case study authors, reviewers, and invited experts, to develop an experts view on the present use of EIA and monitoring in aquaculture.

Documentation

All four regional studies, the special study on salmon aquaculture and the global review synthesis will be presented at the workshop. In addition, a Discussion Guide (Aquaculture and EIA Key Issues, Challenges and Opportunities) is being prepared in advance of the workshop in support of workshop discussions and outputs.

Expected outputs

It is expected that the workshop will provide the materials for the report of the workshop, including guidelines, project synthesis and discussion papers and other contributions, in addition to the global review and synthesis and the five case studies, which will all be published in one FAO Fisheries and Aquaculture Technical Paper.

Venue and date

The workshop will be held from 15 to 17 September 2008 in Rome at FAO Headquarters.

Participants

The workshop will be attended by the five authors of the regional case studies and the special case study on salmon aquaculture, the author of the global review and synthesis, additional invited experts and FAO staff. FAO staff (aquaculture service; legal office) will provide technical secretariat and support for the workshop.

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WORKSHOP AGENDA

Monday 15 September 2008

Introduction

Jiansan Jia	Welcome remarks
All participants	Short introductions of background and interests
Uwe Barg	Introduction – scope – origins – expectations – outputs of the workshop Introduction to case studies TORs & methodology
	Reporting / writing / organizational arrangements

Presentation and discussion of Case Studies and Global Review Synthesis of EIA and monitoring in aquaculture

Chris Nugent	Africa Regional Case Study EIA in aquaculture
	Discussion
lunch break	
Michael Phillips	Asia-Pacific Regional Case Study EIA in aquaculture
	Discussion
coffee / tea break	
Alejandro Flores Nava	Latin America Regional Case Study EIA in aquaculture
	Discussion
Richard Corner	Europe – North America Regional Case Study EIA in aquaculture
	Discussion

Tuesday 16 September 2008

Presentation and discussion of Case Studies and Global Review Synthesis - *Continued*

Kenny Black	Special Case Study EIA in Salmon Aquaculture
	Discussion
Patrick White	Development of programmatic EIAs and monitoring programs for clusters of small-scale cage farmers - The Philippines, a case study
	Discussion
coffee / tea break	
Doris Soto, Jose Aguilar Manjarrez, Elena Irde	CCRF Progress Reporting Surveys, Responses and Analysis Results specific to EIA and monitoring and EIAs in NASOs and NALOs
John Hambrey	Global Review & Synthesis of Case Studies on EIA and monitoring in aquaculture
	Discussion
lunch	

Priority issues for discussion and special working groups: *identifying key findings and recommendations*

John Hambrey	Discussion Guide : Aquaculture and EIA - Key Issues, Challenges and Opportunities
Plenary	Discussion and identification of key issues
Working groups	Working group 1: Management framework;
	Working group 2: EIA procedure and practice
	Working group 3: Monitoring
John Hambrey	Assimilation and organisation of working group recommendations

Wednesday 17 September 2008

Presentation, discussion and refinement of key findings, recommendations and guiding principles

Plenary	Presentation of key issues for discussion (John Hambrey)
	Discussion and finalisation
lunch	
Plenary	Some priority messages
	Dissemination needs and opportunities
	Closing

ANNEX 2

FAO Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture 15–17 September 2008, Rome, FAO headquarters

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ANNEX 3

FAO Technical Workshop on
Environmental Impact Assessment and Monitoring in Aquaculture
15-17 September 2008, Rome, FAO Headquarters

WELCOME REMARKS

Welcome Remarks
by
Mr Jiansan Jia
Chief
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Dear colleagues,

It is with great pleasure that I welcome you all to FAO and, in particular to the FAO Fisheries and Aquaculture Department. We hope you had a nice journey to Rome. It is in fact a significant opportunity to express our appreciation for all the work and efforts carried out by all of you in the preparations for this workshop.

The FAO Fisheries and Aquaculture Department, in particular, my unit, the Aquaculture Management and Conservation Service (FIMA) as well as colleagues from other FAO units, have been working on the Project **Towards sustainable aquaculture: Selected issues and guidelines.** FAO's normative tasks include the development and effective dissemination of technical, policy and strategic advice on aquaculture governance issues, at international, regional, local as well as sectoral and farm levels. This Project, generously funded by the Government of Japan, enabled us to undertake a number of initiatives in support of the promotion of sustainable aquaculture development worldwide. One of the components of this Project, the so-called Component 2, focused on Environmental Impact Assessment and Monitoring in Aquaculture.

Dear colleagues,

We all know that aquaculture is a continuously growing and important food production sector. Aquaculture provides income, employment and can significantly contribute to fish supply and food security in general. However, some aquaculture practices have also caused negative effects, including social and environmental impacts. Concerns and criticism had been voiced against some aquaculture developments. A key issue in this context is to provide adequate information about the environmental impacts of aquaculture operations.

At the same time, better management and planning of aquaculture developments are also needed. It is generally agreed that environmental assessment and planning of aquaculture will help ensure that aquaculture operations are better managed. Information about better environmental management of aquaculture operations will reach and convince the general public about the benefits, costs and other facts of aquaculture developments.

Considerable importance is given to environmental impact assessment and monitoring in aquaculture. The present Component 2 was designed to explore and review the present practices and experiences of development, implementation and, in particular, the effectiveness, of such EIA and monitoring procedures in aquaculture.

Component 2 facilitated the conduct of four regional studies (Africa, Asia, Europe/North America and Latin America) and one specific study on salmon aquaculture as regards EIA and monitoring practices in selected countries. A global review and synthesis has been prepared and this workshop organized.

Dear colleagues,
We expect that the global aquaculture community will learn and in fact benefit from your reviews and studies, as well as from the findings, conclusions and recommendations of this workshop. It is important that our messages are clear and balanced, and above all that they contribute to the sustainable development of aquaculture. However, reality checks are important, and the challenges, constraints and problems of EIA and monitoring in aquaculture also need to be highlighted. We are expected to provide advice on such challenges, and to provide recommendations and guidelines for improvements.

We would like to thank you again for your efforts sofar. We would also like to encourage you to participate actively in the discussions, and to contribute to the success of this workshop. I wish you stimulating discussions during the workshop as well as an enjoyable stay in Rome.

Thank you.

ANNEX 4

FAO Technical Workshop on
Environmental Impact Assessment and Monitoring in Aquaculture
15-17 September 2008, Rome, FAO Headquarters

DISCUSSION GUIDE - AQUACULTURE AND EIA: KEY ISSUES, CHALLENGES AND OPPORTUNITIES

By John Hambrey

CONTENTS

INTRODUCTION

EIA is now widely promoted as an important tool to secure improved environmental management of aquaculture development. A key requirement for its effective application is to couple it with appropriate monitoring procedures. In reviewing their application and effectiveness it is also essential to consider the wider management and regulatory framework.

The FAO Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture will be held in Rome from 15 to 17 September 2008. Four regional reviews of EIA and monitoring in aquaculture (Africa, Asia-Pacific, Europe and North America, Latin America), a special study on EIA and monitoring in salmon aquaculture (herebelow referred to as the ***Reviews***), and also a global review and synthesis have been prepared and will be presented and discussed during this workshop.

This document aims to:

Provide a stimulus and framework for workshop discussions, and the formulation of key findings, conclusions and recommendations.

This Discussion Guide draws on the regional reviews, and the review of EIA and monitoring for salmon aquaculture (the ***"Reviews"***), as well as on the global review and synthesis report to identify some key issues that the workshop could usefully address.

Many specific questions are raised. Some of these, and/or some groups or combinations of these questions, will be used as a starting point for workshop discussions. Many are addressed in more detail in the global review and synthesis report.

It would be useful if you can mark up those particular issues and questions which you consider most important, and add others where you think there is a gap. This will help us to hone and focus workshop discussions. It would also be useful if you could read the global review and synthesis document, where many of these issues are discussed in more detail, drawing on specific examples from the regional reviews and special salmon study (the *"**Reviews**"*). More specifically, please review the compilation of conclusions and recommendations drawn from the review reports which are summarised in the final section of the global review and synthesis report. Please examine these, consider which are the most important, and how they might be developed into more detailed recommendations, taking account of the wider issues addressed above.

For definition/use of key terms, readers are invited to consult Appendix IV of this publication.

THE DEVELOPMENT CONTEXT: CONSISTENCY AND DIVERSITY

The ***Reviews*** cover a huge range of social, economic, political and geographic situations. Perhaps remarkably, where EIA is applied to aquaculture, it tends to be applied broadly following standard international guidelines. In other words - despite the diversity of contexts, there is substantial consistency of approach.

This has both strengths and weaknesses. There is a general desire to seek standardisation within and between countries, especially with respect to environmental legislation. This is driven in particular by the desire for a level playing field, especially for those involved in international trade. On the other hand it is clear that if EIA is to be effective as a key tool in aquaculture sector planning and management, it must be appropriate to local needs, and complementary to other planning and management tools promoting the sustainable development of aquaculture.

The ***Reviews*** also reveal that in practice EIA is not applied to the majority of aquaculture production worldwide. There are different reasons for this. In Japan and the United States of America the management and regulatory framework is already highly developed, and there may be little added value to be gained from applying standardised EIA procedures. In many countries the nature of fish farming - and in particular the very large numbers of small-scale producers, often developing traditionally owned agricultural land - means that EIA for every farm is neither desirable nor feasible. In some countries aquaculture is seen as very much "in tune" with nature, and therefore not requiring EIA.

This raises several related questions:

1. *Can we develop more flexible international or regional guidance for EIA which takes account of the diversity of context?*
2. *Should EIA be promoted as a stand-alone planning and management tool for aquaculture, as it has been in many countries; or does EIA serve as an unnecessary impediment to the sustainable development of aquaculture – and especially small-scale aquaculture?*
3. *Should we be promoting the development of national and local "environmental management systems", with EIA subsumed as one of a suite of tools?*
4. *Should the use of EIA be actively **discouraged** in favour of more strategic management coupled with codes of practice and specific regulatory tools?*

The answers to these and many of the questions raised below will depend upon context, and this should be considered as a cross cutting theme in all discussions.

THE PLANNING AND MANAGEMENT FRAMEWORK

The ***Reviews*** reveal tremendous diversity in terms of the wider regulatory and management framework. In many cases this framework has evolved piecemeal, and is often rather complex and bureaucratic. In other cases the framework has been developed specifically for the aquaculture sector – which is usually not much less complex, but may be more "fit for purpose".

Strategic environmental assessment (SEA) has long been recommended as a tool to allow us to address cumulative environmental impacts – a key issue for aquaculture development – and should also inform the development of sector plans and environmental management mechanisms more generally. The ***Reviews*** offer very little practical experience of its application or effectiveness.

5. *Is there more practical experience of SEA that we can draw on?*
6. *Is SEA a precondition for more effective, streamlined and predictable EIA?*
7. *At what geographic scale should SEA be undertaken?*

Standards (norms) and assessment criteria are widely regarded as essential preconditions for effective EIA. These are well developed in some countries and poorly developed in others. Usually they are developed at national level by technical specialists, though there are exceptions where there is a strong decentralised natural resource planning system. Standards may be developed:

- Nationally for classes of land or waterbody;
- Nationally for aquaculture effluents/discharges;
- Nationally for aquaculture "zones";
- Locally for aquaculture effluents/discharges;
- Locally for specified zones/waterbodies/land areas.

In some cases local standards are developed which must be equivalent to, or more precautionary/demanding, than those established at national level.

In order to support better environmental management of aquaculture, and where relevant streamline and improve the quality of EIA:

8. *At what geographic scale or scales should standards be developed?*
9. *Should standards be related to aquaculture, or to waterbodies/land/water use zones, or to both?*
10. *Who should develop these standards and how?*
11. *How does this relate to SEA and EIA?*

AQUACULTURE DEVELOPMENT PLANS AND INTEGRATED COASTAL/ WATERSHED MANAGEMENT

Countries vary greatly in the extent to which they "plan" aquaculture development, and the nature of such plans. Plans may be developed based on some form of SEA, as means to deliver national targets, or based on local discussions and needs. They may be highly *prescriptive* with clear zones and associated regulations, or simply offer higher level objectives and broad guidance on issues of growth, finance, location, management, *etc.* They may or may not have significance for the nature of, and outcome of, EIA. Plans may relate to the aquaculture sector, or to a range of activities within coastal zones or watersheds (see: integrated coastal zone management or intergrated watershed management).

12. *How useful is aquaculture development planning?*
13. *At what geographic scale is it most usefully undertaken?*
14. *Should it be informed by SEA?*
15. *Should it provide the framework and context for EIA?*
16. *If well done, does it remove the need for EIA?*
17. *Should aquaculture planning be subsumed under integrated coastal/watershed management or developed as a reasonably coherent sector plan?*

ENVIRONMENTAL CAPACITY

The need to understand and where possible estimate environmental capacity and carrying capacity in order to manage cumulative impact is widely accepted, and there are examples of its application from Asia, Latin America, North America, and Europe. These relate mainly to larger waterbodies such as reservoirs, lakes, and lochs, sea inlets or enclosed bays but can also be applied to more complex systems. Assessment techniques range from relatively simple, rough, and low cost approaches (such as mass balance) to highly complex modelling of dispersion and assimilation processes. Once carrying capacity has been estimated, the tough question remains as to how to ensure that the levels of aquaculture do not exceed it, and how to allocate available capacity in an equitable way.

18. *Is an understanding of carrying capacity a pre-condition for effective EIA or SEA?*
19. *What are the most cost effective approaches to estimating environmental capacity? Do they vary according to physical/geographic and economic conditions?*
20. *What is the most appropriate geographic scale for the estimation of environmental capacity?*
21. *How can we make more effective use of estimates of environmental capacity in terms of limiting aquaculture and other activity within carrying capacity?*
22. *Is there a need and opportunity to produce/disseminate better guidance on estimating environmental capacity?*

USE RIGHTS

The issue of a permit or license to farm fish is now very widespread and regarded as a pre-requisite for better environmental management. In some cases a license is contingent upon production of a satisfactory Environmental Impact Statement (EIS) or Environmental Management Plan (EMP) - and other more specific conditions. In some countries several different permits or licenses are required (*e.g.* in relation to water use; waste discharge; chemical use; use of introduced species; conversion of land/habitat, *etc*.).

The duration of permits or use rights varies greatly – from one year (trial license) to infinity. A longer license period has the advantage of encouraging investment; a shorter period allows for the application of an evolving management regime, and for more adaptive management.

23. *How can permitting and licensing procedures be streamlined and simplified? Is one license better than many?*
24. *Should EIA be the catch-all assessment in relation to the many permits or the many dimensions of one permit?*
25. *Can guidance be offered on the duration of use rights/permits? What are the key issues to consider?*
26. *Can licenses/permits/quotas be usefully issued in relation to a certain proportion of environmental capacity?*
27. *Should most or all licenses/quotas be made tradable?*

ENVIRONMENTAL MANAGEMENT SYSTEMS

The key issue which emerges in the global review is the lack of clear “management system” in many countries. By environmental management system we mean here a process or regime (at anything from farm level to national level) encompassing at minimum the following:

- basic understanding of resources available and their relative value;
- clear and broadly agreed environmental objectives and associated indicators, targets or thresholds;
- a strategy and associated mechanisms through which the objectives will be achieved;
- a monitoring and review system which provides the information required to appraise success in terms of meeting objectives;
- a response/adaptation mechanism which adapts or changes the strategy and mechanisms in the light of monitoring and review.

Such a system would also integrate all the various tools and mechanisms for environmental management of aquaculture to ensure that they are effective and complementary rather than duplicating/overlapping.

28. *Should we/how can we shift the emphasis from EIA to environmental management systems (farm level; regional level; national level)?*
29. *How can we control the tendency to constantly add to regulation.*

SCOPE, PURPOSE AND EXECUTION OF EIA

The need for, scope, purpose and execution of EIA depends upon the nature of the industry, its state of development, and the nature of the broader environmental management framework. The ***Reviews*** suggest that this diversity of context is not fully reflected in the specific requirements and guidance for EIA. In order to improve the application of EIA it is important that the objectives for EIA are clearly spelt out in any guidance, taking full account of the national and local context and existing environmental controls.

More specifically – and this is reflected in several of the ***Reviews*** - there is a need to ensure that EIA focuses on those issues which it is most usefully able to address. Some form of risk analysis is often proposed, as part of the screening and scoping stages of a given EIA process. Risk analysis might also be applied at regional or national level in order to inform EIA guidance materials.

30. *What part should risk analysis play in refining the focus of EIA and/or in the environmental management framework more generally? Should it be applied as part of a national strategy to define the key issues to be addressed? Or as part of the EIA process itself? Or both?*

It is not unusual for EIA to address issues which are already dealt with through specific regulatory mechanisms (such as pollution/discharge controls) or industry codes of practice. It is important that where these are considered under EIA, duplication is avoided and any analysis is complementary.

31. *Can guidance on screening and scoping be improved to take account of the need for risk analysis and minimal duplication?*

Equally there are many issues which are very important, but which cannot easily be addressed through site specific EIA. These include issues related to species introductions, disease, environmental capacity, and some dimensions of social and economic impact.

32. *Should some key environmental issues be specifically excluded from EIA because they require regional or national strategies or specific regulation?*

Screening typically uses standard thresholds in terms of size, type, intensity or species to determine whether EIA is required. These vary significantly between countries.

33. *Are standard thresholds (e.g. scale, production) appropriate as a means of targeting EIA?*
34. *Should EIA be applied to proposals for expansion as well as establishment? How can this be done without undermining the attractiveness and growth potential of a proposed enterprise?*
35. *Shellfish farming and extensive or semi-intensive production techniques are commonly excluded from EIA requirements. Is this appropriate?*

In several countries (including Japan, Thailand, some parts of the United States of America) EIA is not required for fish farming, and other mechanisms are used to manage the environmental effects of aquaculture, including planning, regulation, codes of conduct, infrastructure, monitoring and response mechanisms.

36. *Is EIA appropriate as a tool for the environmental management of aquaculture? What are the advantages and disadvantages of EIA compared with alternative approaches and management frameworks.*

37. *Can we define more clearly the circumstances in which EIA is likely to be:*
    - *an essential tool;*
    - *a supporting tool, complementary to other approaches;*
    - *a costly and bureaucratic diversion.*

The quality of EIAs is questioned in several of the ***Reviews***. In some countries this is addressed through EIA practitioner approval or accreditation schemes. However, aquaculture EIA may be undertaken by EIA generalists with little understanding of aquaculture systems, and this is more difficult to address.

38. *How can the capacity of EIA practitioners be raised and the quality of EIAs improved specifically in relation to aquaculture?*

Predictive models are used increasingly to assess possible impacts of farms or groups of farms.

39. *How useful are predictive models, compared with monitoring and response procedures?*

DECISION-MAKING PROCEDURES

The development of a fish farm has potential environmental, social, and economic impacts. Deciding what is or is not acceptable has both technical/scientific and social/cultural dimensions. Some aspects of assessment and decision making can be relatively objective (e.g. use of toxic chemicals); others much more subjective (e.g. landscape impacts). Some may be objective but uncertain (e.g. impacts of escapes on wild fisheries or native flora and fauna).

Most countries address these issues through various forms of consultation. A panel or committee may be convened to make or review critical decisions. In many countries there is also a requirement for accessibility of documents and transparency of decision making procedures.

Unfortunately the subjective nature of much decision making (and especially the social/cultural dimensions) introduces uncertainty into the EIA/licensing process, and this can make investment in aquaculture less attractive. This may be compounded in countries where public consultation is given significant weight, and where some sectors of society (local, national or both) are opposed to aquaculture development. The site specific nature of EIA may serve as a focus for polarized viewpoints, for the attention of campaigns or particular national and international lobby groups.

40. *How can decision making procedures be improved to decrease uncertainty and avoid conflict?*
41. *How should economic benefits be balanced against possible environmental impacts, and how can the various trade-offs be clarified? What is the role of risk analysis? Should economic impact be given more attention in EIA?*
42. *How can the interests of diverse members of society, both locally and nationally, be more effectively accounted and balanced? Are there opportunities for "polling" approaches?*
43. *What should be the balance between national guidance, coupled with clear decision criteria, and informed professional judgement?*
44. *How do adversarial approaches ("constructive" tension between institutions representing different interests) compare with more "integrated" approaches?*
45. *Who/what kind of institution should make the final decisions?*
46. *How far can we take the idea of "transparency"?*
47. *How do decisions on particular (licence) conditions relate to decisions on a proposal as a whole?*
48. *Is higher level strategic planning an effective way to minimize conflict and uncertainty, and improve the quality of decision-making in relation to specific sites?*
49. *How can decision-making capacity be improved at all levels?*

IMPLEMENTATION, MONITORING AND FEEDBACK/ADAPTIVE MECHANISMS

The ***Reviews*** reveal that despite "best practice" recommendations, EIA tends to be a one-off permitting event. There is rarely significant follow-through in terms of ensuring that specific conditions, or more comprehensive environmental management plans arising from the EIA, are implemented or monitored. Indeed where monitoring of fish farms does take place this is often part of a wider government scheme related to specific regulations, or to government monitoring of the sector, or the wider environment more generally. Furthermore, although much monitoring information may be recorded, it is rarely analysed and fed back effectively into the planning and management regime.

Responsibility for monitoring varies significantly. This may be assigned to:

- producers themselves;
- independent auditors;
- government institutions.

Responsibilities and response procedures (*i.e.* action to take should problems arise, or initial conditions be violated) are often unclear.

Monitoring can be very costly, and the ***Reviews*** reveal several examples where ambitious monitoring schemes have run into difficulties in terms of cost, capacity and manpower.

50. *What are the most effective mechanisms for ensuring compliance with farm permits and associated conditions, and any associated monitoring requirements?*
51. *What should be the scope of farm level monitoring, and should this be defined through EIA, or through sector level regulatory regimes?*
52. *What is the role of EIA, if any, in defining or contributing to wider environmental monitoring requirements?*
53. *At what geographic scale(s) and at what level of detail is environmental monitoring most effectively undertaken?*
54. *How can monitoring be more effectively focussed on key parameters, and streamlined to reduce cost and increase effectiveness? Can risk assessment be usefully applied to improve focus? Is there a role for public participation in selection of parameters?*
55. *Can the numbers of indicators/parameters be reduced from a purely technical perspective (e.g. do we use too many highly correlated parameters/indicators?)*
56. *There are differences between countries in terms of key parameters used in environmental monitoring associated with aquaculture. What is to be learned from experience so far?*
57. *How does video transect monitoring compare with more traditional grab techniques in terms of cost and utility?*
58. *Are some monitoring parameters more effective than others in terms of eliciting farmer interest and response?*
59. *To what extent can calculation and prediction be substituted for actual monitoring more widely (e.g. relationship between biomass or feed input and nutrient output)?*
60. *Do we need to clarify the distinction between monitoring for management and monitoring for research?*
61. *Who should be responsible for different types/levels of monitoring? Who should be responsible for quality assurance?*
62. *How can feedback of monitoring information into farm level and sector level management be made more effective? How does this/should this relate to setting of environmental quality standards for farms/bays/ecosystems/use zones/national land/water classifications.*

COMPLEMENTARY PROCESSES AND REINFORCEMENT MECHANISMS

Codes of conduct, codes of practice and best management practices have been widely promoted and are increasingly adopted. They are promoted by both farmers and government. They are seen as a way to:

- promote farmer responsibility;
- reduce the needs for regulation;
- pass the costs of regulation directly to the farmer;
- access market opportunities.

In some countries (*e.g.* Norway, United States of America) codes of practice are embedded within the regulatory regime as part of the permitting process. In some countries the code is seen as the guiding management framework, with recommendations and protocols for environmental management at all levels from national strategy, through regional and local plans to site management.

63. *To what extent do codes and best management practice (BMP) initiatives - reinforced where appropriate through targeted regulation - reduce or remove the need for EIA and associated farm specific environmental management plans?*
64. *What are the strengths and weaknesses of compulsory versus voluntary codes?*
65. *How can the need for* ***sector*** *level management be reflected in codes of conduct directed primarily at* ***individual*** *farms?*
66. *Can BMPs be developed and used more effectively in education/extension?*
67. *Is there a role for EIA in complementing sector level codes with site level refinements? How could such a role be formalised?*

OVERALL

The ***Reviews*** reveal rather disappointing application and effectiveness of EIA as a significant tool for the environmental management of aquaculture.

68. *How do we reduce bureaucracy and increase cost effectiveness? What are the priorities?*
69. *How can effective environmental management systems – rather than individual management tools – be promoted more widely?*
70. *Can we summarize the strengths and weakness of different approaches to the use of EIA? Are there some groups or "classes" of approach which we can analyse and compare?*
71. *Can we offer generic guidance on how EIA should be integrated with other mechanisms for environmental management to maximise its effectiveness?*

PART 3

Towards policy guidelines

Part 3 – Towards policy guidelines

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Hambrey, J.B. 2009. Towards policy guidelines. In FAO. Environmental impact assessment and monitoring in aquaculture. *FAO Fisheries and Aquaculture Technical Paper.* No. 527. Rome, FAO. pp. 619–636.

ABSTRACT

This section presents elements of introductory guidance for consideration of key issues associated with EIA and monitoring in relation to aquaculture development worldwide. It draws on the substantial analysis of environmental impact assessment and monitoring presented in the regional reviews, special salmon review, synthesis report and the deliberations of the workshop. It is necessarily relatively simple and generic; more prescriptive guidance cannot be developed without reference to the particular circumstances in different countries.

CONTENTS

Introduction

"Environmental Impact Assessment and Monitoring in Aquaculture" is one component of the FAO project "Towards sustainable aquaculture: selected issues and guidelines", (GCP/INT/936/JPN), which was implemented by FIMA, FAO's Aquaculture Management Service, with the generous support of the Government of Japan.

The Project Component on "Environmental Impact Assessment and Monitoring in Aquaculture" aims to address key issues of environmental assessment and monitoring in aquaculture with view to generate strategic advice and technical guidance information for use in policy-making, capacity-building and training in the sector. Special attention was given to different aquaculture farming systems, different environments and different socio-economic contexts of development, with particular consideration of special circumstances and requirements of developing countries.

This section is based on the activities and results generated by this Project Component, which include the findings of four regional reviews, a special salmon aquaculture study, and a global review and synthesis of EIA and monitoring in aquaculture, as well as on the deliberations, views and recommendations of the FAO Technical Workshop on EIA and monitoring in aquaculture, held from 15 to 17 September 2008 at FAO headquarters in Rome.

Most of the material for this section was derived from both the above regional and global reviews as well as from contributions to, and recommendations from the technical workshop. The relevant references and sources are presented in the bibliography of the section on the Global Review and Synthesis of EIA and monitoring of aquaculture, which can be found in Part 1 of this publication.

The purpose of the present section is to provide interested readers with elements of preliminary guidance on key issues associated with EIA, environmental monitoring and management systems in aquaculture. The section is necessarily simple, generic and short.

It is emphasized that this section is not prescriptive. Specific guidance usually can only be developed with reference to particular circumstances in different countries. Readers are encouraged to review this section, and the available reference materials, with a view to developing their own views and identifying their priorities and options for change and improved management, and to consider preparing relevant and effective policy and technical guidelines, as necessary, in order to further promote the sustainable development of aquaculture.

DEFINITIONS AND MEANING

The IAIA (1999) define **Environmental Impact Assessment** as;

> *"The process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made"*

A more process driven definition, which encompasses management as well as assessment is offered by Sadler and McCabe (2002):

> *"The systematic, reproducible and interdisciplinary identification, prediction and evaluation, mitigation and management of impacts from a proposed development and its reasonable alternatives".*

In practice different countries have different and more specific definitions and associated guidelines, although the basic process is remarkably similar between countries.

It is important that each country should have its own clear definition of EIA as applied to aquaculture, along with clear objectives and appropriate guidance materials.

We also refer to "**strategic environmental assessment**" throughout this report. For the purposes of these documents, and in order to encompass the range of different definitions used throughout the world, we propose the following "general" definition:

Strategic environmental assessment is the process of identifying, predicting, evaluating and mitigating the biophysical, social, and other relevant effects associated with existing or new economic activities under a particular plan or programme, within a particular sector, or within an identified physical area or region.

SEA therefore encompasses procedures such as programmatic EA, regional EA, and sector EA. The core idea is that the collection of information relating to many actual or possible developments is used to inform a higher level strategic response, in terms of management and mitigation measures for the sector, for a particular area, or in relation to a government programme. The level at which SEA is undertaken is a key issue for more effective management of aquaculture development.

Monitoring is a broad term which may refer to:

- the collection of information on the state of the environment before and after development, designed to assess the actual impacts of the development;
- the routine collection of information on the state of the environment unrelated to a specific development, but which may be relevant to the management of the sector or indeed of the wider environment;
- the collection of information on the practical implementation of mitigation measures arising from EIA or other conditional permitting procedures.

THE NEED FOR BETTER ENVIRONMENTAL MANAGEMENT OF AQUACULTURE

Aquaculture is growing rapidly throughout the world and generates exceptional quality food products and raw materials. Production is likely to overtake that of fisheries in the next few years (Brugere and Ridler, 2004; FAO, 2006; 2007). It has a substantial influence on land, water, natural resources and the communities that depend on them. Some forms of aquaculture have the potential for significant environmental effect (Box 1).

It is essential that the social and environmental issues are understood, and taken into account in aquaculture development planning and management.

Equally it should be understood that most aquaculture is relatively benign and generates tremendous social and economic benefits, and should not be overly constrained by complex and bureaucratic procedures.

DIVERSITY

Aquaculture is hugely varied throughout the world. It ranges from back garden ponds and subsistence production to global companies producing thousands of tonnes of shrimp or salmon. It takes place in cold mountain streams, tropical floodplains and

BOX 1
Possible environmental effects of aquaculture

- Effects on water and sediment quality.
- Habitat and land-use change.
- Effects of chemicals/medicines on ecology and humans.
- Release of disease organisms and carriers.
- Escape of genetically changed and alien species, and direct/indirect impacts on biodiversity and fisheries.
- Resource use conflict (navigation; fisheries; farming).
- Cultural effects (landscape; demography).
- Indirect impacts associated with inputs (food, fertilizer etc) on the wider environment.

ocean pens. It may use wild seed stock or highly cultivated strains. The fish, shellfish and seaweeds produced may depend on natural nutrients or food, or be fed fresh fish or highly formulated pelleted diets.

When considering the needs for EIA and monitoring, diversity – between and within countries, between different types of environments, and between different forms of aquaculture – must be taken into account.

RELEVANCE AND APPLICATION

It is clear from the definitions of EIA offered above, that it is intended to apply to "major" development decisions, and this is reflected in the fact that in those countries where EIA is required for aquaculture, there is usually a size threshold to ensure that it does not overly constrain small-scale producers or overburden regulators. This means that it is only routinely applied to proposals for large scale finfish and shrimp farm development. Since at a global level most fish farming is conducted on a relatively small-scale, EIA does not apply to most aquaculture activity. We need alternative forms of environmental management for small farms.

Governments need to develop more effective mechanisms to manage groups or clusters of small farms, and the aquaculture sector as a whole.

In a few countries with significant fish farming industry (such as Japan, Thailand, and parts of Egypt and the United States of America) EIA as such is not applied to aquaculture at any scale, and the government authorities rely on alternative environmental assessment and management mechanisms to promote sustainability of the industry.

An effective management framework

BUILDING A MANAGEMENT SYSTEM

The global review and synthesis (see Part 1) reveals that in the absence of an effective environmental management framework for aquaculture, EIA and monitoring can become largely pointless bureaucratic procedures which do little to protect the environment, while at the same time constraining enterprise, and in some cases serving as a barrier to entry.

There are several key requirements for such a framework, which the global review and synthesis reveals are often lacking:

Clear environmental objectives and associated standards, against which environmental impact can be assessed and monitoring systems designed.

Procedures which focus environmental assessment, mitigation, regulation and monitoring on the greatest social or environmental threats.

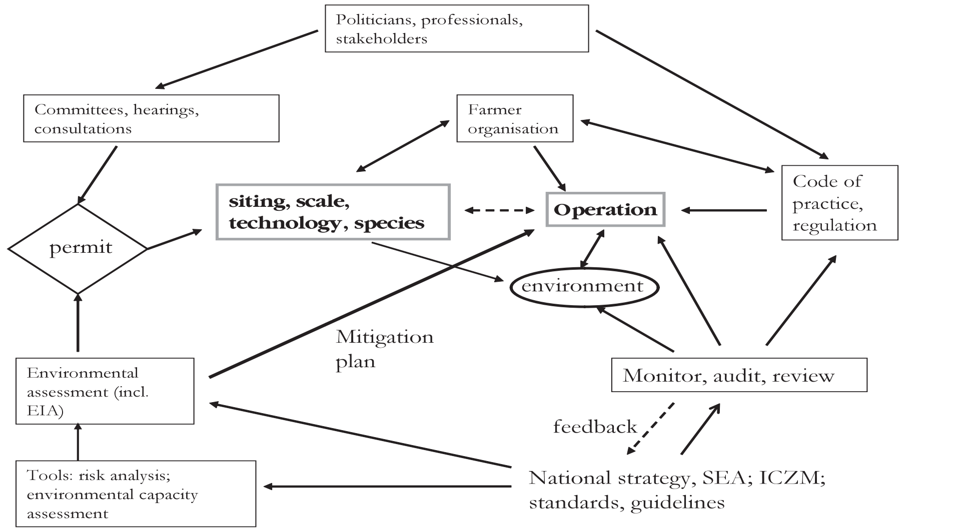
Cost effective monitoring of both the environment, and the implementation and effectiveness of any mitigation measures.

Analysis of monitoring data providing feedback into both sector level and farm level management.

If the feedback mechanism is effective, this becomes a *management system*, rather than a management framework. Through a process of learning and adaptation, a management system should become steadily more effective as experience is accumulated.

The key elements in an effective management system for aquaculture, and the place and role of EIA and monitoring within it are shown in Figure 1.

FIGURE 1
An environmental management system for aquaculture



At the heart of the management system is aquaculture, whose social and environmental impacts are defined by siting, and by operational decisions and practices. The various elements in an effective management system seek to influence both siting (through permit procedures) and operation (through regulation and codes of practice) for the benefit of both the industry itself and wider society. The relative importance of these different elements, and the way in which they are used, will depend on the type of aquaculture and the special circumstances in each country and region. Without monitoring and feedback however, there is little prospect of improved management.

DEVELOPING STRATEGY AND STANDARDS

EIA or simpler forms of environmental assessment cannot be undertaken in isolation: they must refer to the values and standards of society in the form of environmental objectives and associated indicators and reference points. In some cases these may already exist as part of wider frameworks for the management of natural resources, and in particular water quality. In other cases they may need to be established either for the wider environment, or specifically in relation to aquaculture.

> *Standards should be developed and agreed as part of a* ***national or regional strategy*** *for aquaculture, which identifies key issues and offers guidance or sets standards.*

Desirable elements in such strategies might include the following:

- identification of most important social, economic and environmental issues;
- higher level objectives and possibly targets in relation to these issues;
- standards and protocols for addressing these issues at national level;
- standards and protocols for addressing these issues at more local level;
- procedures for making, or agreeing trade-offs between different needs and objectives at local level;
- issues of farmer organization, representation and responsibility;
- institutions and decision-making procedures more generally.
- identification of specific opportunities for aquaculture development, in terms of location, technology, species, markets, products etc
- identification/confirmation of proper and adequate scales for reference and action.

Ideally there would be a hierarchy of such strategies: at national level, at the level of an identifiable waterbody or watershed, and at a local government level.

These strategies may be informed by strategic environmental assessment. Equally they may form a part of a broader integrated coastal or watershed management plan.

Reducing complexity and increasing efficacy

There is much potential for complexity, duplication and grinding bureaucracy in such a management system. The key to developing more efficient procedures is to address issues at the right scale, to minimize duplication, and to ensure that all assessment and monitoring is focused on the most important issues.

SCALE ISSUES

Some environmental issues are best dealt with through regulation or protocols at regional or national level because their effects are pervasive and wide ranging[1].

These might include, for example, the introduction of alien or genetically modified species. The issues surrounding such introductions are complex and require risk analysis and research at national or higher level, and assessment of likely costs and benefits to the sector and the country as a whole, and the development of appropriate regulations or protocols. These issues cannot easily be dealt with through EIA at an individual farm site, unless this is used as a "test case".

Similarly the use of certain chemicals and antibiotics should be subject to national policy, regulation and protocol, though in some cases there may be need for local interpretation and adaptation.

REDUCING DUPLICATION

Tackling management issues at the right scale should itself reduce duplication. However, there are opportunities to reduce duplication at all levels. Thus most EIA generates a set of mitigation measures, which may be formalized as an environmental management plan. This may overlap with codes of practice for the sector as a whole or for particular sub-sectors which will include a range of generic mitigation measures.

Those issues that are effectively dealt with through the application of generic codes of practice should not be revisited in EIA and associated mitigation/ environmental management plans, unless there are exceptional local circumstances that require this.

Similarly there may be standard national regulation relating to the release of certain wastes.

A site level EIA should only consider how the farm will comply with standard regulations, and unless there are exceptional local circumstances, should not consider in detail the wider effects of the release of these wastes.

[1] Table 3 in the global reviews and synthesis section (see Part 1) offers a brief analysis of the strengths and weaknesses of EIA, and levels and types of management appropriate to some of the more important issues associated with aquaculture development.

REFINING FOCUS AND TARGETING EFFORT

Much environmental assessment – at all levels - is characterized by long check lists and analysis of a wide range of issues. Often this results in comprehensive documents which still lack adequate analysis of the most significant issues. Most EIA guidelines emphasize the need for *screening* to identify developments most likely to cause serious impact, and *scoping* of the issues associated with a particular development, in order to focus on the most important.

The detail and extent of the analysis should always be proportionate to level of threat.

Despite the guidance, the global review and synthesis reveals that screening and scoping are often inadequate, and much EIA gets bogged down in unnecessary detail.

A more explicit emphasis on risk analysis at all levels of assessment, and particularly in screening and scoping, should improve focus and administrative efficiency.

Small-scale production and cumulative impacts

Most aquaculture is small-scale and not included under standard EIA procedures. Notwithstanding its small-scale the cumulative impacts from many small developments can be substantial – often more substantial than those from a few large farms.

It is essential that small-scale developments are brought within the management system.

FARMER ORGANIZATION AND MANAGEMENT "CLUSTERS"

Effective management of large numbers of small-scale farms cannot be done without ***effective farmer organization*** - so that farms can develop a sense of shared responsibility; so that management measures can be applied more efficiently; and so that extension messages and learning good practice can spread more rapidly.

Farmer organizations should be promoted at a scale appropriate to important environmental management issues, and encouraged to take responsibility for group or "cluster" management initiatives.

ENVIRONMENTAL CAPACITY

Cumulative aquaculture development has often "overshot" the capacity of the environment to assimilate waste, with resulting poor water and sediment quality, declining productivity, and eventually chronic disease. This has happened particularly in Asia where large numbers of small-scale development have sometimes mushroomed out of control, with a resultant collapse of the industry, or decline into chronic poor performance.

In order to avoid this it is important to make estimates of the carrying capacity of the environment. These should be based on:

- estimates of waste production from fish farming and other sources;
- estimates of the assimilative capacity of the environment; and
- agreement on acceptable levels of change in terms of environmental quality.

There is a range of tools available to tackle these issues, from relatively simple mass balance calculations to more complex models of dispersion and assimilation.

Countries should seek to make assessments of environmental capacity for all water-bodies or identifiable aquatic systems where fish farming is likely to develop as a significant activity.

Assessment of environmental capacity at a strategic waterbody/watershed level may also allow for the identification of sector level mitigation, such as:

- exploiting the potential synergies between input based aquaculture (such as intensive finfish or shrimp culture) and extractive aquaculture (such as mollusk production);
- identification of zones of greatest environmental capacity where aquaculture is likely to have minimal impact.

Once capacity has been estimated, mechanisms should be agreed which will ensure that development does not exceed capacity. This will require some form of allocation of limited capacity to producers.

EIA Procedures

As noted above, site level EIA may only be practicable and useful in relation to reasonably large aquaculture developments. Most countries have size or production thresholds, or criteria relating to the sensitivity of the habitat or the risks associated with the technology.

STANDARD PROCEDURES

EIA procedures have become relatively standardized across the globe, and are summarized in Box 2.

The main variations between countries relate to the level of detail of assessment and the various names given to these. Some countries have a staged approach under which a "preliminary" or "initial" EIA is undertaken which may or may not lead to a more comprehensive EIA. Some countries apply different levels of EIA to different categories of development.

As suggested above, the key to more efficient EIA procedures is to ensure focus and effectiveness.

The *objectives of EIA for aquaculture should be clearly stated.*

EIA should be undertaken when it is the most effective tool to achieve the overall objective of sustainable development, taking account of the nature and scope of aquaculture development, and the characteristics of the environment.

Site level EIA should take account of the findings of higher level strategic assessment and national policy more generally.

Assessment and evaluation should be focused on the most important issues, and on those which are not already addressed under alternative environmental management mechanisms (such as standard regulation or best practice initiatives).

This will require an iterative approach – exploring a wide range of issues initially and narrowing the focus steadily through risk analysis coupled with a careful evaluation of the value of information for final decision-making.

BOX 2
Typical steps in EIA

1. **Screening**: what is the scale and significance of likely environmental effects? What level or detail of assessment, if any, is required?
2. **Scoping:** identify the most serious or potentially serious issues and impacts; draw up TOR for the assessment.
3. **Assessment**: more detailed identification of impacts; prediction and analysis of effects; significance of impacts; comparison of alternatives (where these are proposed);
4. **Mitigation**: identification of site, technology or management options which will minimize identified adverse impacts;
5. **Reporting**
6. **Decision**: unconditional approval; conditional approval; rejection
7. **Monitoring**: procedures for reporting performance and effectiveness of mitigation

A list of useful guidance documents relating to environmental assessment of aquaculture can be found in the bibliography at the end of the global review and synthesis (see Part 1 of this publication).

SOCIAL AND ECONOMIC IMPACT

Given its name, it is unsurprising that social and economic impacts are often given limited attention in EIA. Sometimes these issues are addressed under related procedures as part of the permitting process, but this is not always the case.

There are advantages in making assessment more comprehensive to include these issues, not least because any significant environmental impact is likely to have social and economic consequences. Indeed social and economic impact is likely to be an important criterion for prioritizing environmental impact.

Social and economic impact assessment should be included in, or closely integrated with EIA procedures.

TOOLS

EIA can become very complex. There are many tools which can enhance the quality and accessibility of the assessment:

- **risk analysis** – to refine the focus of the assessment on priority issues;
- **presentation, visualization and communications** tools – which ensure that the assessment is accessible to widest possible range of stakeholders;
- **models** which generate predictions of possible impacts and their effects, including hydrological and environmental capacity models, which can be developed at different levels of accuracy and complexity according to resources and need;
- **decision support** tools, ranging from GIS to trade off analysis and multi-criteria decision analysis.

There is a danger however that tools become an end in themselves, demanding ever more data and resources, with marginal contribution to informed decision-making.

The wide range of tools available should be used wherever appropriate and cost effective to enhance the quality and accessibility of EIA.

PARTICIPATION

Stakeholder participation in EIA is a standard recommendation in most EIA guidance. However, fair and inclusive public consultation is costly and may generate conflict. Therefore it should be well informed and carefully managed.

Many issues are better dealt with at higher levels where generic standards and protocols can be widely agreed. Other issues are largely technical and can be addressed by competent agencies or government departments. The focus of EIA consultation should be on local subjective and/or socio-economic issues which national guidance is inadequate to address.

Ensure that consultation is focused on those issues which require public/stakeholder input.

Ensure that skilled and impartial management and facilitation is provided.

COMPETENT AUTHORITY

The competent authority – the institution which coordinates EIA and makes the final associated permitting decision – varies from country to country. In some cases it is the sectoral agency or department (fisheries, aquaculture). In many cases it is the environment agency or department. In some countries it is local government. In a few countries a special independent commission may be responsible for final permitting decisions.

Where the sectoral agency is responsible, EIA is likely to be better informed (technically), more streamlined and predictable. However, there may be a tendency of bias in favour of development. Similarly there are advantages and disadvantages of more centralized as oppose to more local decision-making. The latter will have a better grasp of local issues, the former will be less constrained by local politics and better placed to take account of national and higher level strategic interests.

Whatever approach is taken, it is important that the fisheries/aquaculture institutions do have a significant role in advice, planning and decision-making.

Institutions and decision-making

Many countries have detailed legislation relating to environmental assessment, and procedures are often set down in some detail. However, environmental assessment and monitoring should be associated with effective and consistent decision-making if these procedures are to feed back into better management of the sector.

While some of the decisions may be relatively straightforward and objective (for example a water quality threshold will be breached), others may relate to highly uncertain or subjective issues.

Impacts on ecology and biodiversity for example are often highly complex and uncertain, and the values associated with different elements difficult to agree. Impacts on society and other users may present difficult trade-off decisions. Impacts on landscape are largely subjective. Perceptions and values in relation to these issues may vary between local and national level and between different interest groups.

This split between relatively objective issues, uncertain issues and subjective issues should be clarified and reflected in decision-making processes.

Ideally the more objective issues are dealt with through sound science, standard regulation and protocol; uncertain issues are dealt with through more rigorous risk analysis; and the more subjective and local issues are dealt with through case by case EIA or local planning procedures.

Monitoring

There is little point in applying EIA or other management tools in the absence of effective environmental monitoring.

Monitoring should be a key issue to be addressed in any national or regional aquaculture strategy.

TYPES OF MONITORING

A monitoring programme for the industry should encompass a range of monitoring requirements:

- *Monitoring the implementation and effectiveness of mitigation measures identified in EIA or SEA;*
- *Monitoring compliance with and effectiveness of codes of practice or other good practice instruments;*
- *Monitoring compliance with and effectiveness of standard regulation (e.g. wastewater limits);*
- *Farm level environmental monitoring to enhance environmental and economic performance, and where possible to complement wider environmental monitoring schemes;*
- *Monitoring in the wider environment by regulatory authorities to ensure that national standards are not breached and that appropriate adaptive management is put in place.*

SCOPE AND FOCUS

With regard to monitoring in the wider environment (usually undertaken by government authorities) the main problems identified in the regional reviews related to the ambition and scope of such monitoring, and the lack of resources and capacity to analyse, report and use this data to improve management of the sector as a whole.

Monitoring should be focused on key parameters defined through a rigorous process of risk analysis and value of information analysis.

The scope of monitoring should take account of resource availability and capacity to usefully analyse the data generated.

ANALYSIS AND FEEDBACK

Inadequate or limited analysis of monitoring data, and lack of feedback mechanisms to adjust management interventions in the light of such analysis (at both farm and sector level), were widely reported in the regional reviews.

Clear procedures should be established for the analysis and reporting of monitoring data, and the effective use of this information to adapt and refine the management response.

Overall

The regional reviews and the deliberations of the workshop which took place from 15 to 17 September 2008 at FAO headquarters in Rome suggest the following key messages:

1. EIA and monitoring should be applied within a wider environmental management system for aquaculture guided by aquaculture strategies developed at national and waterbody level.
2. EIA and monitoring procedures should reflect the diversity of aquaculture, environments and the social, economic and political context.
3. Duplication and complexity should be minimized to reduce the bureaucratic load on farmers.
4. The focus for EIA and monitoring should be refined through rigorous risk analysis to identify and prioritize key issues.
5. Environmental management mechanisms should be developed to address cumulative impacts associated with small-scale aquaculture which typically fall outside the scope of EIA and associated monitoring.
6. Estimates of environmental capacity should be made for identifiable waterbodies, and permitting procedures or allocations should be used to keep aquaculture development within this capacity.
7. Decision-making procedures, and the role of public participation, should reflect the diversity of decision types: technical/objective; uncertain; subjective.
8. Monitoring data should be analysed regularly and the results used to identify management needs and refine management interventions.
9. Capacity building (human and institutional resources) might be needed to facilitate the development of effective aquaculture sector specific environmental management systems.

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PART 4

Appendices

FAO Project and Technical Workshop on Environmental Impact Assessment and Monitoring in Aquaculture

Appendix 1

Appendix 1 provides the Terms of Reference for preparation of four regional and one special case studies on EIA and monitoring in aquaculture, under project FAO/JPN/TF-GCP/936: Towards sustainable aquaculture: Selected issues and guidelines; Component 2: EIA and monitoring in aquaculture.

TERMS OF REFERENCE FOR REGIONAL CASE STUDIES IN FOUR REGIONS

Background and scope

Component 2 – "**EIA and monitoring in aquaculture**" of the FAO Project "Towards sustainable aquaculture: Selected issues and guidelines" envisages two major activities (see *Annex 1* for Description of the Project's Component 2). The First Activity foresees the:

- Compilation, review and synthesis of existing EIA and environmental monitoring procedures and practices in aquaculture.

Four Regional Case Studies will cover the compilation and review of existing EIA and environmental monitoring procedures and practices in aquaculture in selected countries of the four Composite Regions. The selection of the following countries is based primarily and pragmatically on their total aquaculture production volume and share in a given region, a preferred focus on major aquaculture commodities (e.g. salmon, tilapia, trout, catfish, sea bass, gouper, shrimp, carps, bivalves, etc), and assumed availability of and access to sufficient information in the countries, as follows:

Africa:	Egypt, Nigeria, Mozambique, South Africa, Uganda, (others: Madagascar, Tanzania, Zambia);
Asia/Oceania:	China, Australia, India, Indonesia, Japan, Malaysia, Philippines, Thailand, Viet Nam (others: Bangladesh, Sri Lanka, South Korea)
Europe/NorthAmerica:	Czech Republic, France, Greece, Hungary, Italy, Netherlands, Poland, Spain, Turkey, UK, and Canada/ United States of America
Latin America:	Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico

For each country covered the focus of study will be on the top three aquaculture species/commodities produced.

The author is informed that a special case study is being undertaken separately with respect to EIA and environmental monitoring in cage aquaculture of salmon in Canada, Chile, Ireland, New Zealand, Norway, UK and United States of America. The Terms of Reference for this study are attached for information and reference by the authors of the regional studies (see Annex 2).

A synthesis report will be prepared once these four regional case studies and the special salmon cage aquaculture study are finalized.

Specific tasks for the author of the Regional Case Study in [the region given]

Each Regional Case Study will give special consideration to four areas related to EIA and monitoring in aquaculture including : (1) the requirements; (2) the practice, (3) the effectiveness and (4) suggestions for improvements.

The author of the Regional Case Study in *[the given region]* will compile and review existing EIA and environmental monitoring procedures and practices in aquaculture in the countries highlighted in section (1) Background and Scope, and in particular undertake the following tasks:

Checking the requirements

1. Compile and review the regulatory / legal requirements of (1) conducting and presenting EIA studies/statements before establishment and operation of aquaculture farms, and (2) conducting and presenting EIA studies/statements during operation of a given aquaculture farm (i.e. those EIA studies/statements that are required in licences/permits which have to renewed, or which may regulate conditions for expansion, intensification, etc);
2. Compile and review the regulatory / legal requirements of regular conduct and presentation of environmental impact monitoring efforts during the operation of a given aquaculture farm (the emphasis here is on regularly conducted environmental monitoring efforts);
3. Compile and review the soft-law based , recommended practices and procedures for EIA and environmental monitoring measures, as mandated by voluntary instruments such as codes of practice, best practice guidelines, certification schemes, etc, as and where existing;

Checking the practice

4. Record and describe the methodologies and procedures (environmental assessment and monitoring methods, sampling techniques, data recording/interpretation, etc) applied for the EIA and monitoring efforts used, the personnel and expenses involved, and the difficulties and constraints in implementing such EIA studies and recurrent environmental monitoring efforts

Checking the effectiveness

5. Appraise the efficiency and effectiveness of existing EIA and monitoring requirements and practices, as stipulated in both obligatory and voluntary instruments, with particular emphasis on :
   (a) the technical appropriateness of the application and conduct of EIA and monitoring methodologies in such studies;
   (b) the use (by investors, producers, regulators, etc) of generated data and information for improved performance in aquaculture site/system selection, farm development, operation and management;
   (c) assessment, control, maintenance or improvement of environmental quality (parameters, standards, objectives) in a given environment (site, location, habitat, ecosystem), as used and affected by a given aquaculture development with a view to appraising the effective outcome of the EIA and monitoring efforts (assessing the actual effect – positive, nil, negative - on the given environment of such efforts). In other words, how is it ensured that these EIA studies are actually meaningful and effective for protection of the environment (does it make a difference to have these EIAs, for example to prevent from eutrophication?).;
   (d) use of generated information for improved management, in particular response and enforcement measures (required adjustments by producers in response to monitoring results vis-à-vis established thresholds) – verification and validation of results;
   (e) the existence of feedback mechanism and regular revision and review of the legal requirements for EIA and monitoring procedures and practices of a prevailing EIA system for aquaculture;

(f) the general perception of stakeholders (producers, environmental and other NGOs, scientists, etc) about the effectiveness of the requirements.

Suggesting possible improvements

6. With regard to findings and conclusions on the above, identify and discuss technical/scientific, financial, social and jurisdictional/legal issues (constraints, problems) and suggest areas and opportunities for possible improvements, (eg. adjustments/modifications of existing EIA & monitoring requirements and practices), needs for capacity building, competency development, and for collaboration between producers, producer organizations, EIA & monitoring experts, regulators, NGOs, certifiers, etc.

For the purposes of the above tasks, the author will compile relevant information as may be available in sources such as the scientific literature, professional & trade journals, grey literature, internet, regulatory authorities, industry associations, aquaculture or fisheries societies, environmental organizations, individual experts.

Expected Output

The author will write (using MS WORD and other supporting MS software) a comprehensive review paper in English, including tables, graphs, etc., providing all available references and sources to documentation including that published on the internet. The document will include abstract, summary, and contents as per above listed specific tasks. The author will acknowledge all contacted persons and institutions providing substantial input to the Study. The author will follow and apply FAO editorial and publishing guidelines to the expected document.

TERMS OF REFERENCE FOR SALMON AQUACULTURE CASE STUDY IN SALMON PRODUCER COUNTRIES

Background and scope

Component 2 – "**EIA and monitoring in aquaculture**" of the FAO Project "Towards sustainable aquaculture: Selected issues and guidelines" envisages two major activities; 1) Compilation, review and synthesis (based on desk studies) of existing EIA and monitoring procedures and practices in aquaculture and 2) Identification - through scoping/ranking case studies and a technical seminar - of environmental assessment approaches and methodologies most suitable to different production systems, commodities and environments.

The present terms of reference involve the First Activity which includes the following subcomponents:

a) Four Regional Case Studies will cover the compilation and review of existing EIA and environmental monitoring procedures and practices in aquaculture in selected countries of the four Composite Regions. The selection of the following countries is based primarily and pragmatically on their total aquaculture production volume and share in a given region, a preferred focus on major aquaculture commodities (e.g. salmon, tilapia, trout, catfish, seabass, gouper, shrimp, carps, bivalves, etc), and assumed availability of and access to sufficient information in the countries, as follows:

Africa:	Egypt, Nigeria, Madagascar, South Africa, (others: Tanzania, Uganda, Zambia);
Asia/Oceania:	China, Australia, India, Indonesia, Japan, Malaysia, Philippines, Thailand, Viet Nam (others: Bangladesh, Sri Lanka, South Korea)

Europe/NorthAmerica:	Czech Republic, France, Greece, Hungary, Italy, Netherlands, Poland, Spain, Turkey, UK, and Canada/United States of America
Latin America:	Brazil, Colombia, Cuba, Ecuador, Honduras, Mexico

For each country covered the focus of study will be on the top three aquaculture species/commodities produced.

b) A special case study on EIA and environmental monitoring in cage aquaculture of salmon in Canada, Chile, Ireland, New Zealand, Norway, UK and United States of America.

A synthesis report will be prepared once these four regional case studies and the special salmon cage aquaculture study are finalized.

Specific tasks for the author of the Salmon Farming Case Study (SALEIA)

SALEIA will give special consideration to four areas related to EIA and monitoring in including: (1) the requirements; (2) the practice, (3) the effectiveness and (4) suggestions for improvements.

The author of the SALEIA will compile and review existing EIA and environmental monitoring procedures and practices in salmon farming in the countries highlighted in section (1) Background and Scope, and in particular undertake the following tasks :

Checking the requirements

7. Compile and review the regulatory / legal requirements of (1) conducting and presenting EIA studies/statements before establishment and operation of salmon farming, and (2) conducting and presenting EIA studies/statements during operation of a farm (i.e. those EIA studies/statements that are required in licences/permits which have to be renewed, or which may regulate conditions for expansion, intensification, etc);
8. Compile and review the regulatory / legal requirements of regular conduct and presentation of environmental impact monitoring efforts during the operation of a farm (the emphasis here is on regularly conducted environmental monitoring efforts);
9. Compile and review the soft-law based , recommended practices and procedures for EIA and environmental monitoring measures, as mandated by voluntary instruments such as codes of practice, best practice guidelines, certification schemes, etc, as and where existing;

Checking the practice

10. Record and describe the methodologies and procedures (environmental assessment and monitoring methods, sampling techniques, data recording/interpretation, etc) applied for the EIA and monitoring efforts used, the personnel and expenses involved, and the difficulties and constraints in implementing such EIA studies and recurrent environmental monitoring efforts

Checking the effectiveness

11. Appraise the efficiency and effectiveness of existing EIA and monitoring requirements and practices, as stipulated in both obligatory and voluntary instruments, with particular emphasis on :
    (g) the technical appropriateness of the application and conduct of EIA and monitoring methodologies in such studies;
    (h) the use (by investors, producers, regulators, etc) of generated data and information for improved performance in aquaculture site/system selection, farm development, operation and management;

(i) assessment, control, maintenance or improvement of environmental quality (parameters, standards, objectives) in a given environment (site, location, habitat, ecosystem), as used and affected by a given aquaculture development with a view to appraising the effective outcome of the EIA and monitoring efforts (assessing the actual effect – positive, nil, negative - on the given environment of such efforts). In other words, how is it ensured that these EIA studies are actually meaningful and effective for protection of the environment (does it make a difference to have these EIAs, for example to prevent from eutrophication?).;
(j) use of generated information for improved management, in particular response and enforcement measures (required adjustments by producers in response to monitoring results vis-à-vis established thresholds) – verification and validation of results;
(k) the existence of feedback mechanism and regular revision and review of the legal requirements for EIA and monitoring procedures and practices of a prevailing EIA system for salmonfarming;
(l) the general perception of stakeholders (producers, environmental and other NGOs, scientists, etc) about the effectiveness of the requirements.

Suggesting possible improvements

12. With regard to findings and conclusions on the above, identify and discuss technical/scientific, financial, social and jurisdictional/legal issues (constraints, problems) and suggest areas and opportunities for possible improvements, (eg. adjustments/modifications of existing EIA & monitoring requirements and practices), needs for capacity building, competency development, and for collaboration between producers, producer organizations, EIA & monitoring experts, regulators, NGOs, certifiers, etc.
13. Provide a synthesis Table or other format for comparative analysis of the countries included regarding requirements, practice and effectiveness

For the purposes of the above tasks, the author will compile relevant information as may be available in sources such as the scientific literature, professional & trade journals, grey literature, internet, regulatory authorities, industry associations, aquaculture or fisheries societies, environmental organizations, individual experts.

Expected Output

The author will write (using MS WORD and other supporting MS software) a comprehensive review paper in English, including tables, graphs, etc., providing all available references and sources to documentation including that published on the internet. The document will include abstract, summary, and contents as per above listed specific tasks. The author will acknowledge all contacted persons and institutions providing substantial input to the Study. The author will follow and apply FAO editorial and publishing guidelines to the expected document.

Appendix 2

Description of Project Component 2: Environmental Impact Assessment and Monitoring in Aquaculture, within Project FAO/JPN/TF-GCP/936: Towards sustainable aquaculture: Selected issues and guidelines.

[2] B.1 PROBLEMS TO BE ADDRESSED: THE PRESENT SITUATION

Aquaculture is a significant and continuously growing food production sector. In many cases it provides income, employment and can significantly contribute to supply of much needed protein and food security in general. However, in many cases aquaculture practices have also caused negative effects, including social, economic and environmental impacts. The result in many cases has been that serious concerns have been expressed about the overall environmental sustainability of aquaculture practices, and strong criticism had been voiced against aquaculture developments.

A key issue in this context is to provide adequate and generally accepted information about the environmental impacts of aquaculture operations. Generating and regularly updating technical and scientific information about ecological effects of given aquaculture operations, within an administrative and legal framework for environmental assessment and management of aquaculture, will in many cases ensure that aquaculture operations are better managed and that such information about better environmental management of aquaculture operations will reach and convince the general public about the benefits and costs of aquaculture developments.

Given the importance of environmental impact assessment and monitoring in aquaculture, the FAO Questionnaires on Progress in the Implementation of the CCRF in its section on aquaculture do include questions to FAO member states regarding the existence and development of procedures for environmental impact assessment and monitoring. The responses by FAO Members States so far indicate that there is a wide range of diverse types of EIA and monitoring procedures, and that the extent of development, implementation and effectiveness of such EIA and monitoring procedures, where existing, also varies form country to country.

In many cases, EIA and monitoring procedures in aquaculture do not exist, are not sufficiently developed or implemented, and often appear to be inadequately designed to provide key information on changes in the ecological features of the specific environments sustaining given aquaculture practices. Often, there are little or no efforts to ensure regular monitoring of environmental performance and environmental outcomes of aquaculture farm management measures, after the completion and submission of the EIAs required for the establishment of aquaculture farms.

[2] B.2 EXPECTED SITUATION AT THE END OF THE ASSISTANCE PROJECT

The project component on Environmental Impact Assessment and Monitoring in Aquaculture will address key issues of environmental assessment and monitoring in aquaculture with view to generate strategic advice and technical guidance information for use in policy-making, capacity-building and training in the sector. Special attention will be given to different aquaculture farming systems, different environments and different socio-economic contexts of development, with particular consideration of special circumstances and requirements of developing countries.

[2] B.3 TARGET BENEFICIARIES OF THE PROJECT

The immediate beneficiaries will be technical, legal and planning staff in management and scientific institutions as well as private sector and other non-governmental stakeholders concerned with sustainable aquaculture development. Intermediate beneficiaries will be policy-makers as well as trainers, fish farmers and resource managers who will have a better understanding of how to evaluate and select most appropriate environmental impact assessment and monitoring methods in aquaculture. Ultimate beneficiaries will be society once such approaches and methods are applied regularly, efficiently and cost-effectively.

[2] B.4 STRATEGY

This project component will commission a series of reviews and desk studies on current practices and experiences of environmental assessment and monitoring in aquaculture. These papers will be used in a technical seminar for analytical comparison and scoping of environmental assessment approaches and methodologies most suitable to different production systems, commodities and environments. All review papers, desk studies and recommendations from the seminar will be published for dissemination to and use by beneficiaries.

[2] B.5 INSTITUTIONAL ARRANGEMENTS

This project component will operate from the FAO Headquarters in Rome with the involvement of the following FAO technical services FIRI (lead unit), FIPL, LEGN and Regional and Sub-Regional Offices, and selected partner institutions, as appropriate.

[2] B.6 RELATIONSHIPS WITH OTHER PROGRAMMES

The project should take cognisance of and cooperate with the following projects and parties: The involvement of other programmes is not planned.

[2] C. DEVELOPMENT OBJECTIVE

The longer-term development objective is the contribution to improved and effective environmental assessment and management of aquaculture resulting from the regular, efficient and effective application of EIA and monitoring approaches and methods.

[2] D. OBJECTIVES, OUTPUTS AND ACTIVITIES

[2] D.1 MEDIUM-TERM OBJECTIVE

To facilitate and enable policy makers and other project beneficiaries to develop and implement improved environmental assessment and management plans in aquaculture, based on improved understanding of how to evaluate and select most appropriate environmental impact assessment and monitoring methods in aquaculture

[2] D.2 IMMEDIATE OBJECTIVE

This component will target the following immediate objective:

- To develop of a global overview, including comparison and synthesis, of existing procedures and methodologies of environmental impact assessment and monitoring in aquaculture.

[2] D.3 OUTPUT AND ACTIVITIES

The following output and two major activities will be undertaken to achieve the above objective:

Output 2: Global overview and analysis of existing procedures and methodologies of Environmental Impact Assessment and Monitoring in aquaculture.

Activity 2.1. Compilation, review and synthesis (based on desk studies) of existing EIA and monitoring procedures and practices in aquaculture (based on CCRF Questionnaire responses and other sources of information)

Activity 2.2. Identification - through scoping/ranking case studies and a technical seminar - of environmental assessment approaches and methodologies most suitable to different production systems, commodities and environments.

Appendix 3

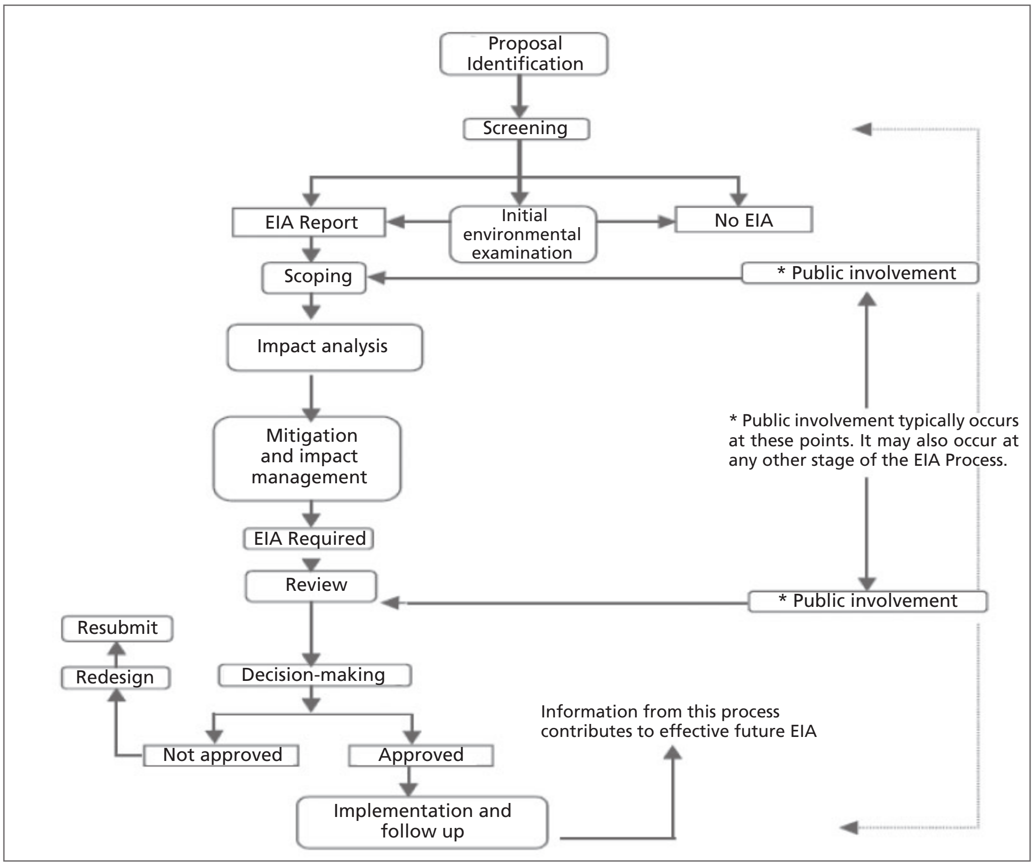
USE OF KEY TERMS[1]

There are numerous definitions of key terms such as "environmental impact assessment" (EIA), "monitoring", and "strategic environmental assessment" (SEA). Only a small number of examples of definitions of these key terms are presented herebelow as found in a few national and international sources. In addition, two related useful online databases are suggested for further information and research:

ECOLEX is a database providing the most comprehensive, global source of information on environmental law. ECOLEX is operated jointly by FAO, IUCN and UNEP.
http://www.ecolex.org/start.php

FAOLEX is a comprehensive and up-to-date computerized legislative database, one of the world's largest electronic collections of national laws and regulations on food, agriculture and renewable natural resources. FAOLEX is operated by FAO's Legal Office.
http://faolex.fao.org/faolex/

The following diagram provides a generalized EIA process flow chart.



Source: Sadler, B. and McCabe, M. (Eds). 2002. UNEP Environmental Impact Assessment Training Resource Manual, Second Edition. Geneva, United Nations Environment Programme, Economics and Trade Branch. 561 p.
http://www.unep.ch/etb/publications/EIAMan2editionToc.php

[1] Compiled by Elena Irde and Uwe Barg, FAO Aquaculture Management and Conservation Service, Rome, 2008.

(1) Examples of definitions of EIA and monitoring as found in national legislation

Country	Definition of term	Source
Canada	"*Environmental assessment*" means, in respect of a project, an assessment of the environmental effects of the project that is conducted in accordance with this Act and regulations. http://laws.justice.gc.ca/en/c-15.2/text.html *Environmental assessment* is a process to predict the environmental effects of proposed initiatives before they are carried out. An environmental assessment: (i) identifies possible environmental effects; (ii) proposes measures to mitigate adverse effects, and (iii) predicts whether there will be significant adverse environmental effects, even after the mitigation is implemented. http://www.ceaa.gc.ca/012/002/CEAA-Overview_e.pdf	Canada. 2002. Canadian Environmental Assessment Act (1992, c. 37). (as amended in 2003) Canadian Environmental Assessment Agency. 2003. What is environmental assessment?, pp 5-6. In Canadian environmental assessment act. An overview. 43 pp
China	The *environment impact assessment* claimed in This Law refers to the method and system of conducting analysis, forecast and evaluation of the possible environment impact brought about by the implementation of plans and construction projects, putting forward the strategy and measures to prevent or reduce the adverse impact on environment, and carrying out follow-up monitoring. http://faolex.fao.org/docs/texts/chn40204.doc	China. 2002. The Law of the People's Republic of China On Environmental Impact Assessments (2002)
Kenya	*Environmental impact assessment* means a systematic examination conducted to determine whether or not a programme, activity or project will have any adverse impacts on the environment; *Environmental monitoring* means the continuous or periodic determination of actual and potential effects of any activity or phenomenon on the environment whether short-term or long-term; http://faolex.fao.org/docs/texts/ken41653.doc	Kenya. 2000. Environmental Management and Co-ordination Act, 1999. (2000)
United Republic of Tanzania	*Environmental impact assessment* means a systematic examination conducted to determine whether or not a programme, activity or project will have any adverse impacts on the environment; Environmental monitoring means the continuous or periodic determination of actual and potential effects of any activity or phenomenon on the environment whether short-term or long-term; http://faolex.fao.org/docs/pdf/tan71740.pdf	United Republic of Tanzania. 2005. Environmental Impact Assessment and Audit Regulations, 2005 (G.N. No. 349 of 2005)
Uganda	*Environmental impact assessment* means a systematic examination conducted to determine whether or not a project will have any adverse impacts on the environment; *Environmental monitoring* means the continuous determination of actual and potential effects of any activity or phenomenon on the environment whether short-term or long-term; http://faolex.fao.org/docs/texts/uga8957.doc	Uganda. 1995. National Environment Statute, 1995 (Statute No. 4 of 1995)
United States of America	*Environmental impact assessment* was first formally established in the United States of America in 1969 by the National Environmental Policy Act and has since spread, in various forms, to many other countries (Glasson, Therivel and Chadwick, 2005). (...) All agencies of the Federal Government shall (A) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decision-making which may have an impact on man's environment; (B) identify and develop methods and procedures (...) which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decision-making along with economic and technical considerations; (C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on: (i) the environmental impact of the proposed action, (ii) any adverse environmental effects which cannot be avoided should the proposal be implemented, (iii) alternatives to the proposed action, (iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and (v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented. (...) http://epw.senate.gov/nepa69.pdf	Glasson, J., Therivel, R., Chadwick, A. 2005. Origins and development, In Introduction to environmental impact assessment: principles and procedures. Third Edition, Routledge, Oxford. 423 pp United States of America. 2000. The National Environmental Policy Act of 1969 (Public Law 91-190), as amended through Dec.31, 2000. Sec. 102 (2). 9 pp.

(2) Examples of definitions of EIA, monitoring, and strategic environmental assessment as found in international guideline publications.

Country	Definition of term	Source
IAIA	*Environmental impact assessment*: The process of identifying, predicting, evaluating and mitigating the biological, social, and other relevant effects of development proposals prior to major decisions being taken and commitments made. http://www.iaia.org/modx/assets/files/PrinciplesofIA_web.pdf)	IAIA. 1999. Principles of environmental impact assessment best practice, International Association for Impact Assessment. 4pp.
UNEP	*EIA* is a systematic process to identify, predict and evaluate the environmental effects of proposed actions and projects. This process is applied prior to major decisions and commitments being made. A broad definition of environment is adopted. Whenever necessary, social, cultural and health effects are considered as an integral part of EIA. Particular attention is given in EIA practice to preventing, mitigating and offsetting the significant adverse effects of proposed undertakings. *EIA* is the systematic, reproducible and interdisciplinary identification, prediction and evaluation, mitigation and management of impacts from a proposed development and its reasonable alternatives. (from glossary) *Monitoring*: activity involving repeated observation, according to a pre-determined schedule, of one or more elements of the environment to detect their characteristics (status and trends). (from glossary) *Strategic environmental assessment*: a formal process of systematic analysis of the environmental effects of development policies, plans, programmes and other proposed strategic actions. This process extends the aims and principles of EIA beyond the project level and when major alternatives are still open. (from glossary). http://www.unep.ch/etb/publications/EIAMan2editionToc.php	Sadler, B. and McCabe, M. (Eds). 2002. UNEP Environmental Impact Assessment Training Resource Manual. Geneva, UNEP. 561 pp.
FAO	*EIA*: a tool used to identify and assess the potential impacts of a proposed project (or activity), evaluate alternatives, and formulate appropriate mitigation, management and monitoring measures (generally in the form of an environmental management plan). *Strategic environmental assessment*: a tool that promotes the incorporation of environmental considerations "upstream" from a project-specific environmental assessment into policy and programme formulation. ftp://ftp.fao.org/docrep/fao/007/x4005e/x4005e00.pdf	FAO. 1999. Environmental impact guidelines. FAO Investment Centre Guidelines No.1: 12 pp.
European Communities	The environmental impact assessment will identify, describe and assess in an appropriate manner, in the light of each individual case (…) the direct and indirect effects of a project on the following factors: • human beings, fauna and flora, • soil, water, air, climate and the landscape, • the inter-action between the factors mentioned in the first and second indents, • material assets and the cultural heritage. http://ec.europa.eu/environment/eia/full-legal-text/85337.htm A *(strategic) environmental assessment*, (…) shall be carried out for plans and programmes (…) which are likely to have significant environmental effects (… plans for agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use and which set the framework for future development consent of projects listed in Annexes I and II to Directive 85/337/EEC, or plans have been determined to require an assessment pursuant to Article 6 or 7 of Directive 92/43/EEC). http://ec.europa.eu/environment/eia/pdf/030923_sea_guidance.pdf	Council of the European Communities. Directive 85/337/EEC on the assessment of the effects of certain public and private projects on the environment. Article 3. European Parliament and Council of European Communities. Directive 2001/42/EC on on the assessment of the effects of certain plans and programmes on the environment. Article 3.
IUCN	An *Environmental Impact Assessment (EIA)* is a preventive policy tool that is now well established worldwide. It is a process that is aimed at producing early and adequate information about the likely environmental consequences of certain plans and projects, and proposing alternatives as well as measures to mitigate harm. A *Strategic Environmental Assessment (SEA)* is a process to estimate the environmental impacts of legislation, policies, plans and programmes. http://cmsdata.iucn.org/downloads/fs10.pdf	IUCN - The World Conservation Union.Water and environmental impact assessment. Water Law Series - Issue 10.

This publication includes four regional reviews on EIA and monitoring in aquaculture in Africa, Asia-Pacific, Europe, Latin America and North America, a special study on EIA as applied to salmon aquaculture, as well as a global review and synthesis which draw on the findings of the review papers, covering information from more than 35 countries. It contains the Report of the Technical Workshop on EIA and Monitoring in Aquaculture held in September 2008. In practice most aquaculture is small scale and is not subject to EIA or rigorous monitoring. Where EIA is applied there is mixed experience. Several weaknesses were identified, including lack of consistency in assessment; lack of appropriate standards; lack of integration between levels and divisions of government; inadequate or ineffective public consultation; lack of assessment skill and capacity; limited follow-up in terms of implementation and monitoring; and excessive bureaucracy and delays. There is limited implementation of monitoring requirements arising from EIA environmental management plans, and limited analysis, reporting and feedback of farm level and wider environmental monitoring programmes into both farm and sector-level management. More emphasis needs to be placed on environmental management frameworks which can address the environmental issues associated with large numbers of small scale developments – including strategic environmental assessment, risk analysis, management plans for waterbodies and/or groups of farms, monitoring and response procedures. Generally, the key to more effective use of both EIA and monitoring procedures will be to nest them within a higher level strategic planning and management framework.

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