PART 2

Selected issues facing fishers and aquaculturists

Selected issues facing fishers and aquaculturists

IMPLEMENTING THE ECOSYSTEM APPROACH TO CAPTURE FISHERIES MANAGEMENT

THE ISSUE

In recent years there has been a growing awareness that the traditional approach to managing fisheries, which considers the target species as independent, self-sustaining populations, is insufficient. It is being recognized that sustainable use of the world's living aquatic resources can only be achieved if both the impacts of the ecosystem on the living resources and the impacts of the fishery on the ecosystem are explicitly identified and, as far as possible, understood. It is also being formally acknowledged that fishers are an integral part of the ecosystem and that both ecosystem and human well-being must be achieved.

Awareness of the essential interactions between populations and their biological, physical and chemical environment is not new. As early as 1376, a group of fishers from the Thames estuary in the United Kingdom expressed their concern to King Edward III of England about the ecosystem impacts of the wondrychoun, a form of beam trawl, which they believed would cause "great damage of the common's realm and the destruction of the fisheries". However, such traditional knowledge was frequently overlooked as fisheries grew rapidly in size and efficiency during the nineteenth and twentieth centuries and as science-based, quantitative methods were developed as a means of estimating how to adjust fishing power to resource productivity. Using the most readily available data from fisheries, simple single-species models became the preferred assessment tool. These models focused all attention on the target resources and on the impact that fishing removals had on their dynamics.

The single-species approach is not the only cause of the widespread inadequacy of conventional fisheries management regimes. However, the dangers and limitations of treating fish populations as entirely self-regulating is well illustrated by examples that include the highly variable small pelagic resources of upwelling systems, the suspected species replacements in areas such as the Georges Bank, and the impacts of riverine and coastal developments on, for example, salmon, sturgeon and shrimp stocks in many areas.

POSSIBLE SOLUTIONS

Fisheries managers and scientists have been slow to respond to the growing evidence that the ecosystem should be considered as a whole. Progress has been impaired by the lack of good-quality, relevant data; the poor understanding of population, ecosystem and fishery dynamics and interactions; and the absence of a credible alternative operational management paradigm. The UN Convention on the Law of the Sea of December 1982 does not explicitly provide for an ecosystem approach to fisheries, even though its main focus in relation to fisheries is with the "living resources" of the sea and the environment. Nevertheless, it does include some provisions that recognize the interdependence of target species with other marine organisms and their dependence on their environment.

By the time that the FAO Code of Conduct for Responsible Fisheries (the Code) was adopted by FAO members in November 1995, the principles of an ecosystem approach to fisheries had started to emerge, including in non-fisheries instruments (such as the Convention on Biological Diversity). The Code reflects this, and includes many important ecosystem considerations that are of relevance to fisheries. In the Introduction to the Code, it is stated that: "The 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." Throughout the Code there are references to different ecosystem considerations, and Article 6 requires states to conserve aquatic ecosystems

(Paragraph 6.1). Paragraph 6.6 advocates that: "Selective and environmentally safe fishing gear and practices should be further developed and applied ... in order to maintain biodiversity and to conserve the population structure and aquatic ecosystems" while Paragraph 7.2.2 specifies that management measures should provide for, among many other factors, conservation of biodiversity, consideration of environmental impacts and minimization of deleterious impacts, such as pollution, discards, catch of non-target species and impacts on associated and dependent species. Effective adherence to these and other provisions of the Code would go a long way towards very effective implementation of an ecosystem approach to fisheries (EAF).

The holistic foundations of the Code were further boosted by the Kyoto Declaration made by the 95 country delegations that met in Kyoto, Japan, from 4 to 9 December 1995 for the International Conference on the Sustainable Contribution of Fisheries to Food Security. These countries declared that they would "base policies, strategies and resource management and utilization for sustainable development of the fisheries sector on the following: i) maintenance of ecological systems; ii) use of the best scientific evidence available; iii) improvement in economic and social well-being; and iv) inter- and intragenerational equity", thereby explicitly linking maintenance of ecological systems with fisheries and fisheries management.

The ecosystem approach to management of the oceans and their resources was consolidated in Agenda 21. Review and coordination of the implementation of these aspects among United Nations agencies was facilitated by the now dissolved Sub-Committee on Ocean and Coastal Areas (SOCA) of the Inter-agency Committee on Sustainable Development (IACSD), operating under the umbrella of the UN Administrative Committee on Coordination (ACC).

At its Ninth Session in July 2000, SOCA considered the need to improve coordination and synergies between regional organizations for fisheries and those for the marine and coastal environment. It concluded that both types of bodies could regard the challenge posed by the development of ecosystem approaches to fisheries management and integrated coastal management as a potential platform for practical cooperation.

As a first step in this direction, it was agreed that a paper centred on ecosystem-based management in fisheries would be developed jointly by FAO and the United Nations Environment Programme (UNEP) and would serve as the basis for potential cooperation among competent regional organizations. The paper summarizes the work that regional organizations have undertaken in relation to ecosystem-based management, outlines possible mechanisms for cooperation, and identifies issues for further consideration. It was subsequently discussed at meetings, both of regional seas conventions and of FAO and non-FAO regional fishery bodies (RFBs).

RECENT ACTIONS

The latest step in the slow process towards formal, global acceptance of the need to manage fisheries as integral components of dynamic ecosystems came with the Conference on Responsible Fisheries in the Marine Ecosystem, which was organized by FAO and the Government of Iceland, with support from the Government of Norway, in Reykjavik in October 2001. At the end of this conference, the Reykjavik Declaration was adopted, including the pledge that the signatory nations would "in an effort to reinforce responsible and sustainable fisheries in the marine ecosystem, ... work on incorporating ecosystem considerations into that management to that aim."

The intent is therefore now firmly in place, but there is still considerable uncertainty as to exactly what is entailed by EAF, and how to implement it. To this end, the Reykjavik Conference requested FAO to develop draft guidelines to be presented at the Twenty-fifth Session of the Committee on Fisheries (COFI) in 2003. This work is in progress, and the guidelines have not yet been finalized. Nevertheless, some EAF principles are widely accepted and will almost certainly feature prominently in the guidelines. These principles are already reflected in the Code and are summarized in the following:

- The first step in implementing EAF is to identify and describe the different exploited ecosystems and their boundaries as discrete entities for the purposes of management. Such classification will be guided by the available knowledge of existing fisheries and target stocks, as well as by other information. A degree of pragmatism will be required for this, as all ecosystems have open boundaries across which exchanges occur. However, the definitions should aim to identify units that are largely independent of surrounding areas, and can therefore be effectively managed as individual entities. This problem, albeit on a far smaller scale, will be familiar to fisheries managers who have already experienced a similar lack of clarity when trying to identify reproductively isolated stocks for management purposes. The definitions of ecosystems should include lists of species of importance, identifying particularly vulnerable or endangered ones, and descriptions of the habitats that are critical for the productivity of the ecosystem.
- Once the ecosystem units have been identified, management objectives must be developed for the fisheries of the ecosystem as a whole in order to facilitate obtaining the optimal benefits in a sustainable manner. In accordance with the UN Law of the Sea and the Code, this should involve – as far as possible – the maintenance or rebuilding of the ecosystem, its habitats and its biodiversity to a status that is capable of supporting all species at levels of maximum production. Clearly, within the goal of optimizing benefits from the system as a whole, there will also be the familiar objectives of conventional fisheries management, which cover economic, social and biological desires at a range of species and fisheries scales. However, in EAF, it is also necessary to recognize the ecosystem interactions and constraints, and to take steps to reconcile the wider objectives so that they are all simultaneously achievable, rather than in conflict. In striving for this reconciliation, the equitable allocation of resources remains a central challenge.
- The objectives of EAF must, of course, go beyond those of the individual fishery or even fisheries sector. Broader objectives must also be considered, including: protection and restoration of critical habitats and nursery and spawning areas; maintenance of the quality, diversity and availability of resources; restoration or rehabilitation of populations and stocks, as far as is reasonably possible; and conservation of biodiversity and population structure. Economic and social objectives should also be considered at this wider ecosystem scale by, for example, taking account of rural livelihoods and other socio-economic activities that have an impact or are dependent on the ecosystem.
- As already stated, the potential conflicts and inconsistencies in these objectives need to be reconciled in order to arrive at a set of simultaneously attainable objectives encompassing biological, ecological, economic, social and institutional concerns. This is likely to be the most contentious part of EAF implementation and will require full consultation with all the legitimate interested parties in order to ensure their support and collaboration.
- Once the objectives have been identified and agreed, suitable reference points or sustainability indicators will need to be established through which to inform managers and interested parties on how successful they are being in achieving objectives or remaining within constraints. The reference points must reflect the range of objectives agreed and be based on the best scientific evidence available. The Scientific Committee for Oceanic Research of the Intergovernmental Oceanographic Commission (IOC), with input from FAO, is currently considering suitable reference points for EAF through its Working Group on Quantitative Ecosystem Indicators for Fisheries Management (see: www.ecosystemindicators.org/).
- Clearly, an effective monitoring system will be required to ensure that the state of the ecosystem can be followed through time and can be compared with the reference points, allowing for corrective action when necessary.

- In fisheries management, management measures are the tools that are used to achieve objectives. Many of the measures that are available for EAF will be the same as those used in conventional single-species management: input controls, output controls, technical measures covering gear and vessel controls, and area and time restrictions. The fundamental needs to avoid excess fishing capacity and to ensure economic conditions that promote responsible fisheries are as important for EAF as they are for single-species approaches. However, fisheries control measures will have to be developed and extended to apply to the broader scope of EAF, and controls on non-fishery users need to become a part of an ecosystem approach to fisheries management. Considering ecosystems instead of single populations will highlight the high levels of uncertainty concerning the status and dynamics of ecosystems and their elements, and intelligent application of the precautionary approach is central to EAF.
- The problems associated with open access systems and systems in which access rights exceed the production capacity of the resources are now a well-known cause of management failure in fisheries. This problem is going to be at least as serious in implementing EAF, and the allocation of various forms of explicit, legally enforceable fishing and other use rights is integral to EAF. In allocating these rights, it is necessary to consider all aspects of the ecosystem and the impacts of all its users, whether they use the ecosystem directly or indirectly. Thus, not only will fishing rights need to be considered, but also development rights, pollution rights, tourism rights and others.
- Implementing EAF entails explicit recognition of the full range of users that have an impact on the ecosystem, and it is necessary to establish effective consultation and decision-making processes for regular consultation with all legitimate stakeholders. EAF's involvement of a broader range of interest groups is likely to require greater time and costs for consultation and decision-making, but is essential for ensuring compliance and cooperation.

FUTURE PERSPECTIVE

Through their support of the Code of Conduct (reinforced by the Kyoto and Reykjavik Declarations) and of the various FAO International Plans of Action, most fishing nations of the world have committed themselves to striving to achieve EAF in order to "contribute to long-term food security and to human development and to assure the effective conservation and sustainable use of the ecosystem and its resources" (Reykjavik Declaration). This could be facilitated by improved relationships between regional fisheries and regional environmental organizations. The instruments establishing both types of institution do not generally provide an explicit mandate for ecosystem-based fisheries management, but there are some exceptions. The International Council for the Exploration of the Sea (ICES), the Commission for the Conservation of Antarctic Living Resources (CCAMLR), the International Baltic Sea Fishery Commission (IBSFC) and other fisheries institutions have undertaken work that is relevant, responsive, sound and credible with respect to marine ecosystems and their relation to humanity. In addition, the work of environmental commissions provides good background information that may be taken into account in the ecosystem-based management of fisheries. Extending the number of regional fisheries organizations with a mandate for adopting an ecosystem approach and forging closer links between environmental and fisheries organizations will facilitate the effective implementation of EAF in fisheries around the globe.

Implementation of EAF is likely to be a slow and difficult process, requiring considerable social and economic adjustments within a global environment that is already facing major social and economic problems. Most countries are already struggling to make good progress in implementation of the Code, and will encounter the same difficulties, and some additional ones, as they strive to achieve an effective ecosystem approach in their fisheries management.

Insufficient financial resources, capacity and expertise, as well as competition with other pressing economic, environmental and social needs, are all hindering progress in implementation of the Code. These problems were anticipated for developing countries under Article 5 of the Code, which highlights the special needs of developing countries, but they have not yet been fully addressed.

An ecosystem approach will require the monitoring and assessment of all aspects of the ecosystem, a wider range of management measures, possibly more control and surveillance, and more time dedicated to interacting with a wider range of stakeholders. National management agencies are typically already fully and frequently overstretched, and EAF will require yet more financial and institutional resources and personnel, unless all parties can find means of distributing their skills and labour more effectively and efficiently. Either way, the transition will not be easy and may also prove costly. While an ecosystem approach to fisheries management should deliver increased benefits in the longer term, as ecosystems recover their productivity and structure, there will be transaction costs. Countries will need to make allowance for these costs, and any global-level implementation will require significant assistance to developing countries so that they can meet the transaction costs and raise their capacity to the required minimum level. In all cases, there will also be a need to look for alternative sources of income to help cover the costs of fisheries management; those who benefit most from fisheries are one obvious potential source of such additional funds.

At present there are widespread public and political concerns about the impacts of fisheries on ecosystems. There can be no doubt that these concerns are justified, even if they are sometimes exaggerated. In many countries, fisheries have limited political and economic weight, and in this era of globalization there is a risk that fisheries activities will be seen as expendable and will be curtailed in cases of doubt, unless there is an adequate response from the fisheries sector to the legitimate environmental concerns. This risk adds to the urgency of developing management approaches that provide acceptable results and are adapted to the various characteristics of countries and resources. In the recent political initiatives, from the Code to the Reykjavik Declaration, the global fisheries community appears to be responding to the environmental concerns and to have realized that progress in achieving EAF is essential for the ongoing productivity of aquatic ecosystems and the well-being of society. The incentives for success, therefore, should be high.

RELIABLE STATISTICS AS AN ESSENTIAL BASIS FOR EFFECTIVE FISHERIES MANAGEMENT

THE ISSUE

Fisheries management and statistics

As in all forms of management, the management of capture fisheries involves synthesizing information, analysis and decision-making.[1] Without reliable information, no supportable decisions can be reached, no diagnoses on the state of fisheries can be performed, and no prognoses on the effects of management control can be made. Fisheries management is subject to natural environmental variability and also to long-term changes that may be human-induced, particularly pollution and climate change.

There is thus far more uncertainty and risk in fisheries management than there is in the management of almost any other food sector or industry. Part of the approach to reducing risk lies in improving understanding through better information, more careful analysis and experimentation, and improved decision-making for long-term results.

The importance of fishery statistics and the effects of unreliability

Most methods and approaches to fisheries management require an assessment of fish stocks in terms of their biomass, size or age composition

[1] D. Evans and R. Grainger. 2002. Gathering data for resource monitoring and fisheries management. *In* P.J.B. Hart and J.D. Reynolds, eds. *Handbook of fish biology and fisheries.* Oxford, UK, Blackwell.

and survival, as well as their responses to natural and fishing mortality. Population models, and their dynamics under environmental and human-induced perturbations, are the principal tools. These require data on how much fish has been caught, the size, age or gender of that fish, and the growth and survival rates that it exhibits, as well as additional information on many other factors. In order to make stock assessments relevant to site-specific fisheries management, such additional information might include data on the place and time of capture, the reproductive status and the behaviour of the fish. It is essential to know what is actually being fished from the wild population, as this affects the stock's ability to survive and, most important, to reproduce and repopulate. This is why catch and effort statistics, along with other data regarding the fish caught, are the key and essential basis for effective fisheries management.

Statistics are often also used for direct administrative management control to ensure that fishers are constrained within the set limits. Fisheries management measures often specify how much fish may be taken, by whom, by what means, when and where. Thus, total allowable catch and licence or quota allocation, fishing gear and operational controls, as well as seasonal and area closures, all require monitoring, much of which can only be achieved by the regular and systematic collection of reliable statistics on the catch and the amount of fishing effort.

Fisheries management should protect the food security and livelihoods of dependent communities and try to ensure that benefits from the surplus production of wild stocks are brought into economies in ways that are appropriate to the political, social and development environments in which they occur. Governments and industries need reliable statistics in order to understand the economic relationships within the fisheries sector and its linkages to other sectors, e.g. finance, energy supply or vessel construction. They must plan for training and investment if potential yields are greater than current yields, or for retraining and stable industry reduction if the existing capacity is greater than appropriate. Communities need catch and effort statistics if they are to achieve and ensure a fair and appropriate distribution of benefits. Policy-makers need such statistics so that fishing communities can be properly represented when sectoral policies are being developed. For example, a recent study[2] of inland fisheries in Southeast Asian countries indicates that catches are several times greater than the official statistics and that communities' dependence on fish as a source of protein, as well as their dependence on the fishing livelihoods of subsistence and small-scale fishers, is far greater than officially recognized, resulting in inadequate recognition of fisheries in social, economic, nutritional and environmental policy-making.

In summary, unreliable statistics confound fisheries management on three fronts. They:

- bring greater uncertainty into the stock assessment process, reducing confidence in the accuracy of fisheries management advice and often resulting in conflict among overcautious fisheries managers, overeager fishers and overanxious environmental advocates;
- reduce the public's confidence in the ability of fisheries managers to monitor and manage these national or international natural resources on its behalf, leading to the belief that, in the absence of control, fishers are overexploiting stocks or fishing in inappropriate ways;
- limit economic and social understanding of the position and viability of fisheries sectors, causing uncertainty about human resources, social structure, capital and infrastructure requirements, both in development and for restructuring.

The reliability of fishery statistics

Ever since the modern fisheries era began, the issue of information reliability has pervaded fisheries management, particularly concerning information about the quantity and location of

[2] FAO. 2002. *Inland capture fishery statistics of Southeast Asia: current status and information needs*, by D. Coates. RAP Publication No. 2002/11. Bangkok, FAO Regional Office for Asia and the Pacific. 121 pp.

catches. As early as the sixteenth century, Portuguese fishers jealously guarded their discovery of the great cod fishing grounds of the Grand Banks in the Northwest Atlantic. As capture fisheries approach maximum yields, scientists require more, and more accurate, data on which to base their analyses. Most fishery assessments concerning stocks, fleets and participants will always depend on reliable catch and effort statistics, as will economic and fisheries management advice. Given the increasing demand for food fish and the acceleration of social change, traditional knowledge, which is often rooted in stable communities where it enjoys high levels of credence, is insufficient. Societies, technology and needs change alongside fisheries, and fisheries management must continually adapt to meet new challenges and circumstances. Reliable statistics are the most essential information that is needed.

The range of types of data required to support fisheries management and policy-making is potentially enormous. However, financial or human resource constraints will force management authorities to limit collection to the most important data types. In 1998, FAO published *Guidelines for the routine collection of capture fishery data*,[3] which sets data requirements within a framework of policy/objectives/indicators/strategy. It also offers advice on methods of data collection, data management and the planning and implementation of data collection systems. It is not prescriptive in that it does not offer a list of data types that are always required. Rather, it describes a decision-making framework through which the most appropriate data are collected for the tasks concerned; much of the fisheries information that is collected around the world may be reliable but is of little value. In terms of fisheries management, reliability includes relevance.

There are several other sources of unreliability. Deliberate misreporting or non-reporting by legal and illegal fishers and other participants (processors, traders) is cited by most managers as a key problem, particularly in developed countries and international fisheries. However, in some fisheries, particularly small-scale and developing country fisheries, either there is no law in place that requires fishery data, or there is little infrastructure for the collection of such data. Even when data are collected, they may be based on inadequate sampling or inappropriate sampling design, the origins of which may be lack of finance or trained personnel.

Bias can also be introduced by the statistical authorities, either inadvertently through the application of inappropriate methodologies, or through systematic distortions that are introduced deliberately, for example, to demonstrate that a particular outcome is in line with international obligations (set total allowable catches) or national policy.

Another problem can be lack of timeliness. For statistics to be useful indicators in fisheries management they need to be prepared regularly and within time frames that provide fisheries managers with short-term guidance. Delays in the preparation of statistics can seriously reduce their utility to fisheries managers. Statistics that are five years old but have only just become available may be reliable, but they may have little relevance for today.

The appropriate confidentiality of fishery data is also a factor in understanding the reliability, and hence usefulness, of fishery statistics. A recent report by the United States National Research Council (NRC)[4] concluded that: "Confidentiality of fisheries data is restrictive to the point of hindering both research and management." The report generally accepted that some fishery data have proprietary value and that "some level of confidentiality is necessary to allow fishermen to

[3] FAO. 1998. *Guidelines for the routine collection of capture fishery data*. FAO Fisheries Technical Paper No. 382. Rome. 98 pp. Prepared at an Expert Consultation, held in Bangkok from 18 to 30 May 1998, organized and funded by the FAO/Danish International Development Agency (DANIDA) project "Training in Fish Stock Assessment and Fishery Research Planning" GCP/INT/575/DEN.

[4] NRC. 2000. *Improving the collection, management and use of marine fisheries data*. Washington, DC, National Academy of Sciences. 160 pp.

maintain their businesses and to promote reporting of high quality information … information that might not be as accurate if it were not confidential". The Code of Conduct for Responsible Fisheries makes several references to applicable confidentiality without defining what it means,[5] partly because its meaning depends on individual fishery circumstances and partly because the legal position regarding business information varies from country to country. Nevertheless, the NRC report recommends that existing United States state and federal policies on data confidentiality should be re-evaluated, including creating a mechanism to establish unique proprietary periods for data confidentiality by fishery and "the effects of the loss of confidentiality on precision and bias (hence reliability) … in setting the proprietary period for each type of data".

This means that lowering confidentiality levels may well result in less reliable information, particularly in fisheries, where knowledge (even transient) of the "best" fishing grounds is the major competitive advantage that fishers have. Confidentiality is therefore not a single dimension. It depends on timing and the needs and authorizations of data users. It also depends on the trust that fishers can expect from data users, including confidence in data security and an understanding of the uses to which data will be put.

POSSIBLE SOLUTIONS

Improving the reliability of fishery statistics

Considerable research and analytical effort are regularly put into assessing the precision and accuracy of fishery data and estimating the extent of the fish catch and fishing effort that is entirely unreported. Statistical techniques of ever-greater complexity attempt to reduce the uncertainty of these missing data. The Organisation for Economic Co-operation and Development (OECD) report of the Workshop on the Significance of Reliable Statistics to Conduct Effective Management[6] notes that: "Even using these techniques it has to be acknowledged that the confidence limits attached to the estimates are wide and contribute significantly to a lack of confidence in the resulting advice."

Notwithstanding this general criticism, it is likely that non-reported data will always have to be estimated in several ways in order to improve the reliability of fishery statistics. Indeed, well-designed sampling surveys[7] can offer good insights into a particular data population (including data that have not been sampled). Good statistical design, including validation mechanisms, is thus a primary means of improving reliability. Validation mechanisms include the periodic conducting of frame surveys, the use of observers and inspectors (as parallel samplers to the complete enumeration approach generally used in logbooks), landings and processing throughput data, and vessel monitoring systems.

It is also often claimed that rights-based fisheries or community co-managed fisheries, in which the control of participants is partly the responsibility of fishers themselves, may also generate more reliable data, as it is in fishers' own best interests to maintain good records and participate in the assessment and management decision-making processes. Certainly, incentives to provide accurate data can be crucial to the reliability of the statistics to which they contribute.

Whereas it is often essential to ensure the confidentiality of data in order to ensure their reliability, the methodologies and processes used to collect and collate them should be fully transparent in order to ensure objectivity. Uncertainty associated with statistics should always be expressed, whether as confidence limits, quality indicators or even annotated comments.

---

[5] FAO. 1995. Code of Conduct for Responsible Fisheries, Article 7 Fisheries Management (7.4.4 and 7.4.7) and Article 12 Fisheries Research (12.3).

[6] Eurostat. 1995. A review of the quality and reliability of fishery statistics. *In* OECD. *Report of the Workshop on the Significance of Reliable Statistics to Conduct Effective Management*. pp. 185–187. Paris.

[7] FAO. 2002. *Sample-based fishery surveys: a technical handbook*, by C. Stamatopoulos. FAO Fisheries Technical Paper No. 425. Rome. 132 pp.

In addition, improving reliable statistics requires cooperation in the development and adoption of standards. Standardization of nomenclature and coding, adoption of agreed statistical methodologies and implementation of transparent information exchange methods require high levels of transboundary agreement so that the nature and origin of fishery statistics is understood across regions, oceans and the world.

In summary, improving the reliability of fishery statistics involves many factors, including:

- legal and other instruments that obligate fishers to supply reliable data and that establish sanctions, penalties and, where possible, incentives to support these measures;
- realistic and useful approaches to data confidentiality, appropriate access to data and, where possible, incentives to data providers to supply reliable information;
- good statistical design that is cost-effective, sustainable and adaptable to changing circumstances and that includes validation systems;
- high-quality and timely information administration and processing that is objective and transparent and that indicates data uncertainty and quality;
- technological innovations, including vessel monitoring systems (onboard and satellite communications), electronic logbooks and point-of-weighing data capture;
- surveillance systems, including inspectors and observers, to monitor catch and effort, discards and dumping, transhipment and illegal fishing.

Such solutions to the problem of unreliable statistics – which hamper or, in some cases, confound fisheries management – require two conditions in order to be implemented: political will and sufficient capacity.

These possible solutions and requirements were identified by FAO members in 2002 at a Technical Consultation on Improving Information on the Status and Trends of Fisheries, which had the specific task of developing a proposal for improving fishery information in a wide variety of ways and at all levels. The Technical Consultation proposed a draft Strategy for Improving Information on Status and Trends of Capture Fisheries, which will be submitted to COFI in 2003.

As well as objectives and guiding principles, the draft strategy contains direct identification of the actions required and the roles of states, RFBs and FAO to improve factual understanding of fisheries and the exchange of information. It recognizes, *inter alia*, the need for: capacity building in developing countries; data collection systems in small-scale fisheries and multispecies fisheries; development of criteria and methods for ensuring information quality and security; and development of arrangements for the provision and exchange of information. The draft strategy is intended to provide a framework that motivates development partner agencies to fund capacity building in order to improve information and statistics on fisheries.

GLOBAL PERSPECTIVE

International responses to the need for reliable fishery statistics

It is generally recognized that the overall quality of fisheries production statistics has deteriorated, in relative terms, during the rapid expansion in fisheries production of the past 50 years. This has been particularly the case since 1982, when the United Nations Conference on the Law of the Sea (UNCLOS) brought about major changes to the regime of the oceans, and developing countries started to experience additional social and economic difficulties. These difficulties arose despite the calls in UNCLOS for "best scientific evidence"; the previous experience of "crashed" fisheries in developed countries, which developing countries could have learned from as their fisheries rapidly grew; and the well-founded and continuing demand for reliable statistics as the principal basis for fish stock assessment and fisheries management.

Part of the problem is undoubtedly a shortage of money and capacity. However, it is also related to the generally low profile of a natural resource that is hidden from the eyes of politicians by its very medium, and to assumptions that fisheries

can be regarded as common property, open-access systems and that market forces may be sufficient to regulate them. In fisheries management none of these assumptions is true; fisheries have a high profile in terms of global protein supply, particularly in developing countries, and small-scale fisheries in inland and marine waters are probably more important than is currently portrayed; open access has inexorably led to overexploitation in almost all the fisheries where it is practised; and global trade has the potential to skew fisheries away from domestic consumption and self-provisioning, sometimes resulting in the overexploitation of food fish for export. Fortunately, changes in attitude and political will are entering the mainstream of fisheries management, particularly since 1992 when the clear linkages between environmental sustainability and development were globally accepted at the United Nations Conference on Environment and Development (UNCED).

For many years prior to 1992, fishery scientists and managers had been calling for better reliability in fishery statistics. They also accepted and explained the need for caution in the way in which they applied their statistical confidence limits to analyses and advice, long before the precautionary approach became the accepted doctrine of environmental concern. In a direct sense, better and more reliable statistics enable a statistical narrowing of confidence limits, hence lowering the degree of caution that needs to be applied.

The need for reliable fishery statistics is still being voiced in all fisheries fora, from COFI to regional and national meetings. The pace of institutional responses, at least at the international and regional levels, is growing. The oldest of the international institutions is the inter-agency Coordinating Working Party on Fishery Statistics (CWP), which was originally established in 1959 for Atlantic fisheries but has more recently changed its statutes to accommodate regional bodies from around the world. CWP has been instrumental in establishing many standards for fishery statistics, and is currently reviewing its role and approach, particularly in the light of concerns about the quality of fishery statistics and the need for capacity building and minimum harmonized quality standards.

The Code of Conduct for Responsible Fisheries calls for reliable fishery statistics in Article 7 Fisheries Management, as follows:

> *7.4.4 States should ensure that timely, complete and* reliable statistics[8] *on catch and fishing effort are collected and maintained in accordance with applicable international standards and practices and in sufficient detail to allow sound statistical analysis. Such data should be updated regularly and verified through an appropriate system. States should compile and disseminate such data in a manner consistent with any applicable confidentiality requirements.*

In applying the Code to specific objectives, international organizations, in particular the UN, FAO and RFBs, have undertaken a number of initiatives that directly and indirectly call for, initiate or provide for improvements in the provision and dissemination of reliable statistics. The UN Fish Stocks Agreement,[9] which came into force in 2001, contains detailed statistical needs in Annex I Standard requirements for the collection and sharing of data, which must be adhered to by all signatories. The FAO Compliance Agreement,[10] which is yet to come into force, also makes reference in Article 7, Exchange of information, to data needs on fishing vessels and their operational authorizations on the high seas, thus providing for fleet data through the administrative identification of authorized fishing effort.

In addition, four international plans of action[11] on specific issues have been developed since

---

[8] Reliable statistics provide the basis for "best scientific evidence", which is prominently referred to throughout the Code, from General Principles (Article 6), Fisheries Management (Article 7), Post-harvest Practices and Trade (Article 11) and Fisheries Research (Article 12).

[9] Agreement for the Implementation of the Provisions of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks.

[10] Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas.

1998, each of which contains determinations on the collection, processing and dissemination of improved data that are directly related to the issue. New approaches to ecosystem-based fisheries management, with high-level requirements for data from a wide range of sources, are also gradually being brought into the mainstream of fisheries management (see Implementing the ecosystem approach to capture fisheries management, p.55).

RFBs are playing an increasingly important role in fisheries management around the world. The earlier organizations focused largely on science and the development of scientific advice but the more recent organizations – including those still being negotiated[12] – are assuming a role in fisheries administration and management. Most RFBs have scientific committees, the tasks of which include issues related to fishery statistics through specific standing committees or working groups.

Outside the framework of specialized fisheries agencies, the world recognizes that good governance and development, including of natural resources, require improved information. In response to a UN Economic and Social Council resolution on rationalizing and improving statistics and indicators, the Partnership in Statistics for Development in the Twenty-first Century (PARIS 21) was established in 1999, based at OECD in Paris. Through advocacy, information exchange and partnerships, PARIS 21 seeks to contribute to more effective poverty reduction and improved transparency, accountability and effectiveness of governance in developing countries and countries in transition. Improving the reliability of capture fishery statistics (as advocated in the FAO draft Strategy on Status and Trends in Fisheries) in order to enable better fisheries management, sustainable fisheries and more effective fisheries governance would undoubtedly contribute to food security and its role in poverty reduction.

There are some tentative signs that the decline of national authorities' and development partner agencies' interest in statistical development, evidenced by the decline of regional and national field projects dealing with fishery statistical development, is beginning to abate. There are indications that recognition of the importance of statistical development within the mainstream of national and regional development planning is reawakening.

CATCH CERTIFICATION AND CATCH DOCUMENTATION

THE ISSUE

Increasing pressure on high seas resources has caused an intensified search for methods to control the fishing effort, particularly methods to obtain information on unreported catches and to help control the fishing effort on heavily fished species. This has led to the introduction of catch certification and catch documentation schemes.

The Atlantic bluefin tuna is one such heavily fished species. This fishery is carried out mainly on the high sea. While the regional fisheries management organization (RFMO) concerned has the authority to regulate the fishing of Atlantic bluefin tunas by its own members, it had no effective means of dealing with vessels flying the flags of non-members, as in high sea fisheries the flag state has the right to control the fishing activities of only its own vessels. This is seen as a problem by countries that are members of the RFBs that manage such fisheries as that for the Atlantic bluefin tuna.

The majority of the vessels of non-members are registered in countries with open registers. Many of these countries are small and have little or no substantial interest in fisheries. As a result, they do not exert control over the vessels that are registered on their open registers. In addition, frequently they do not report landings, or they report only very low landings, generally because the vessels concerned do not land their catches in

[11] The International Plan of Action for Reducing Incidental Catch of Seabirds in Longline Fisheries; the International Plan of Action for the Conservation and Management of Sharks; the International Plan of Action for the Management of Fishing Capacity; and the International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing.

[12] Southeast Atlantic Fisheries Organization (SEAFO); Convention on the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Ocean; Southwest Indian Ocean Fisheries Commission.

their home countries or ports and are not required to report catches to the flag state. This exacerbates the problem and leads to uncertainty about the quantity being caught in any one period, thereby complicating management for the RFB concerned. In addition, as these vessels are under no ñ or little ñ control, when fishing the high seas they can flout the fisheries management rules approved by an RFMO, often deriving economic advantage from doing so. For this reason the vessels registered in open registers are often referred to as "flags of convenience vessels".

This is the context in which it was decided to try to bring pressure on flags of convenience vessels by limiting their possibilities to market their catches.

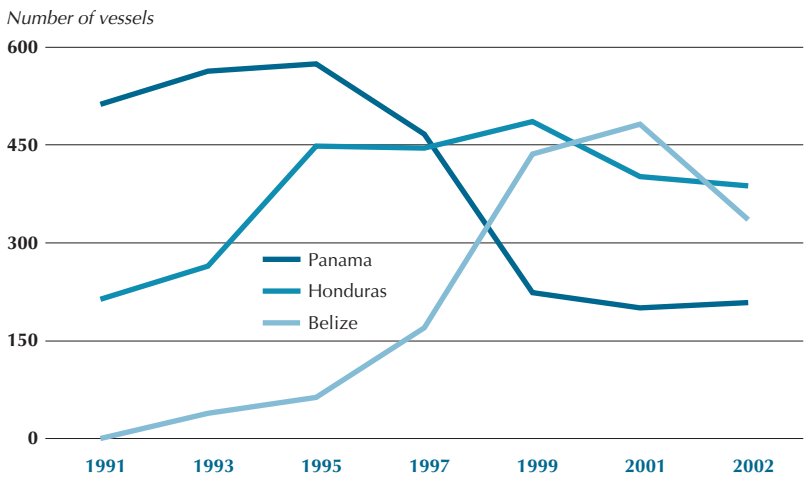
POSSIBLE SOLUTIONS

The International Commission for the Conservation of Atlantic Tunas (ICCAT) was the first RFMO to implement a catch documentation scheme regarding the bluefin tuna caught within its area of jurisdiction. Any bluefin tuna that is imported into any of the ICCAT member countries has to be accompanied by a document that identifies the country of origin. This measure was aimed at recording the catches of vessels that are flagged under countries other than ICCAT members so that the total catches of bluefin tuna can be recorded for management purposes. The document has the rather misleading name of "statistical document". Within a few years, the results of this catch documentation scheme had identified several countries whose flags of convenience vessels were catching up to 30 percent of the total bluefin tuna catch. The introduction of the scheme was facilitated by the fact that Japan and Europe are virtually the sole importers of bluefin tuna.

The ICCAT members agreed among themselves that multilateral trade sanctions should be considered against the open register countries whose vessels were making bluefin tuna catches that did not comply with the ICCAT management measures. The threat of a possible ban on their export of bluefin tuna was enough to encourage these open register countries to join ICCAT and/or to take measures to ensure that they were exercising proper control over the vessels flying their respective flags. Any vessel owners who did not wish to comply with these measures could re-register their vessels in other open registers. This caused significant changes in the registers of Panama, Honduras and Belize, which had many longline vessels of Asian origin.

In November 2001, the European Community (EC) banned the import of some tuna and tuna-like species from specific exporting countries, reflecting the ICCAT management measures, as shown in Table 9. ICCATís success was a useful lesson to other RFMOs that were grappling with the same problem of illegal, unreported and unregulated (IUU) fishing and non-contracting parties. The problems of CCAMLR were very different from those of ICCAT in that CCAMLR was concerned about the overfishing of toothfish in the southern latitudes. In the early 1990s, the catch of toothfish by longline in the very deep waters of southern latitudes had expanded rapidly as a result of its high profitability, and had attracted the attention of many entrepreneurs. The CCAMLR area is very difficult to monitor because of its immense size, the relative lack of coverage by

FIGURE 37
Fluctuations in the main open registers



Note: The decreases shown here were most likely caused by the ICCAT measures.

TABLE 9
EC import bans of tuna and tuna-like species

Exporting country	Bluefin tuna	Swordfish	Bigeye tuna
Belize	Ban	Ban	Ban
Cambodia			Ban
Equatorial Guinea	Ban		Ban
Honduras	Ban	Ban	
St Vincent			Ban

monitoring, control and surveillance (MCS) activity, and the limited presence of exclusive economic zones (EEZs) around the circumpolar region. The French and Australian navies were arresting vessels that had been caught fishing without authorization in the 200-nautical mile EEZs around their respective territories (the Kerguelen and Crozet Islands for France, and the Heard and McDonald Islands for Australia), but significant catches were being made in high seas areas over which no country had jurisdiction; according to some estimates these unreported catches were larger than those reported in the official statistics. In response, CCAMLR introduced a catch documentation scheme. The scheme requires that all the toothfish landed in the ports of its participating parties be accompanied by a catch document, which is authorized by the vessel's flag state and subsequently verified at the port of landing by an authorized flag or port state official. Additional government authorization is required before the toothfish can enter international trade, and the catch document must accompany the toothfish through all stages of the export cycle. Since coming into effect, the scheme has resulted in 18 reports of vessels attempting to land unauthorized catches of toothfish.

Parties to the 1998 Agreement on the International Dolphin Conservation Program (AIDCP) adopted a scheme in June 2001 under which they could issue certificates indicating that canned tuna is "dolphin-safe" (i.e. was harvested without dolphin mortality or serious injury). The dolphin-safe tuna certificate scheme is different from the others in that it is not directed at trade or management measures but at market objectives. Observers are present on all large purse seine vessels. At the time of catch, dolphin-safe tuna is stored separately from tuna that is not dolphin-safe. The tuna tracking number attached to each fish follows it through the system, and copies of the dolphin-safe certificate and the original tuna tracking form are kept by the Secretariat of the Inter-American Tropical Tuna Commission (IATTC). Because it is concerned with environmental issues rather than with fisheries management or trade, this information is not considered to be a trade document (as the tuna and toothfish catch documents are), even though the methodologies of control are similar.

The success of the trade document in providing better catch data and in curbing IUU fishing activities has led ICCAT and other RFMOs to implement similar measures for other species. ICCAT has extended the catch documentation scheme to include swordfish and bigeye tuna. The Indian Ocean Tuna Commission (IOTC) covers bigeye tuna and swordfish with its scheme. This scheme requires certification by officials representing the flag state, and care will have to be taken to ensure that the verification process is carried out in a satisfactory manner. The Commission for the Conservation of Southern Bluefin Tuna (CCSBT) is planning to introduce a catch documentation scheme for Southern bluefin tuna.

RECENT ACTIONS

The proliferation of catch documentation schemes has led the International Coalition of Fisheries Associations (ICFA) to request that all such documentation schemes should be standardized. The Chair of the Meeting of Regional Fisheries Bodies,[13] with FAO assistance, held a meeting in La Jolla, the United States, at which to consider the matter. This meeting produced recommendations on the contents of a standard catch certificate and catch document and on the procedures for processing such a document. FAO is currently designing the

[13] Dr R. Allen, Director, Inter-American Tropical Tuna Commission (IATTC), 8604 La Jolla, CA 92037, USA.

standard documents with input from customs officials who have had experience in handling such documentation. The results will be presented at the Third Meeting of Regional Fisheries Bodies, which is scheduled to take place in March 2003 at FAO, straight after the COFI meeting.

The significance of the terms "catch" and "landings" of fish is often unclear to users and readers. This leads to confusion. CWP has adopted a standard terminology in order to eliminate such confusion and has recommended that FAO and RFMOs using catch documentation schemes should adopt this standard terminology. There have also been problems with implementation, such as choice of the most appropriate conversion factors for estimating live weight equivalent from product weight. Another problem arises from double counting when different parts of the same fish are exported to different countries, each part being accompanied by its own separate set of documents.

The growing practice of fattening bluefin tuna in net cages at tuna farms is making it difficult for the managers of bluefin fisheries to enforce quota allocations. Such farming activity is spreading, particularly in the Mediterranean Basin, where bluefins are caught at sea by purse seines or in traps and subsequently transferred into floating net cages to be fed for a period ranging from a few months to two years.

Recording the volumes of fish caught at sea is a difficult operation, as the fish are generally transferred directly from the purse seines to the net cages without being taken out of the water. At present, such catches are statistically recorded only after the fish have been landed or harvested. The information available, therefore, does not inform managers about which vessels (and which fishing nation) caught the fish, where it was caught and at what size it was caught. This means that the system of allocating bluefin catch quotas to fishing nations becomes increasingly difficult to monitor and enforce.

The Convention establishing the Commission for the Conservation and Management of Highly Migratory Species in the Central and Western Pacific Ocean has not yet entered into force. The Commission does not yet exist as a functioning body, and is not expected to do so for several years. However, the Standing Committee on Tuna and Billfish (an ad hoc meeting of scientists who provide analysis of the fisheries in the region) is considering the introduction of catch certification and trade documentation because there is considerable potential for unreported catches in the Central and Western Pacific area. This is expected to be very difficult to enforce owing to the wide range of fishing fleets involved and the diversity of the ports at which the vessels could land.

IATTC is currently considering a resolution to establish a catch documentation scheme for bigeye tuna taken by longline vessels.

FUTURE PERSPECTIVE

Catch documentation schemes had spectacular success in their early implementation, when they were concerned with one species of large fish from one region that was a target for IUU fishing vessels. Extending the system to smaller fish, in some cases from several vessels or regions, is going to be more problematic and may lead to confusion among species, especially when customs officials have no previous experience of similar initiatives. The problem of customs codes is difficult; however it is thought that the use of catch documentation schemes will, in general, assist in providing better statistics on catches and international trade in fish, as well as identifying IUU fishing vessels and bringing action against them.

While, in principle, the catch certificate and trade document schemes described could be helpful for any fishery managed by an RFMO, it is recommended that priority for the development of new schemes should be given to fisheries that are, or may be, subject to significant levels of IUU fishing. Priority attention should also be given to fisheries harvesting species that are covered by catch certificate or trade document schemes in other fisheries, so as to support the existing schemes of other RFMOs. Consideration should also be given to assisting developing countries in meeting the requirements of catch certification or trade documentation schemes, as many of these countries rely on fisheries products for substantial amounts of foreign exchange.

POVERTY ALLEVIATION IN SMALL-SCALE FISHING COMMUNITIES

THE ISSUE

While economic growth has helped to reduce the proportion of the world's population that is poor, the number of people who remain poor is unacceptably high. The positive impacts of growth on poverty have been less than expected, in part because of inequitable distribution of the benefits, population increases and the effects of the HIV/AIDS epidemic. As a result, many governments and donor agencies have refocused their attention on poverty. The World Bank's World Development Reports for 1990 and 2000, the UN World Food Summit for Social Development in 1995, and the UN Millennium Declaration adopted in 2000[14] all considered poverty alleviation as a principal priority.

In the past, while many development interventions were implicitly aimed at reducing poverty, most did not explicitly focus on improving the living conditions of poor people but aimed at accelerating economic growth through technology and infrastructure development and through market-led economic policies. The lack of an explicit focus on poverty may, in part, explain why the impacts on poverty of many interventions have been neutral, and some may actually have been detrimental. Certainly, the continued levels of poverty in small-scale fishing communities,[15] and in the world as a whole, require that all those concerned take a fresh look at the problem.

It is increasingly acknowledged that poverty is a very complex, multidimensional concept that has many determinants and is concerned with far more than low earnings, i.e. income poverty.[16] An explicit emphasis on poverty is necessary for a better definition and understanding of what it is, so as to be able both to measure progress towards poverty alleviation targets and to gain improved awareness of whom poverty affects and what are the most effective strategies for tackling it.

Poverty in small-scale fishing communities, as in other sectors, is difficult to measure. While there are many studies of poverty in farming communities and among the urban poor, few empirical studies[17] have focused on fisheries. Those that have often concentrate exclusively on income and on the fishers themselves, rather than on a broader concept of poverty in fishing households and communities.

There is now an acceptance that poor fishers and their dependents are not a homogeneous, unchanging group of people. The levels of absolute and relative poverty, within and among small-scale fishing communities, vary considerably by area, country and region.

Although there are poverty traps in fishing communities, over time community members can sometimes become less, rather than more, poor. Fishing communities are often relatively cash-rich compared with farming communities, mainly because fishers sell a larger proportion of their production, more frequently and consistently than do most farmers. They remain vulnerable to sudden variations in earnings, however, making fishing communities often more vulnerable than are communities that rely exclusively on farming. In fact, the issue of vulnerability may be as important as poverty is. It should be recognized, however, that some factors may be important determinants of poverty but not of vulnerability, and vice versa.

Small-scale fishing communities are vulnerable to many events, the outcome of which may be poverty. Examples include: climatic/natural

[14] The Millennium Declaration contains the commitment to halve, by the year 2015, the proportion of the world's population whose income is less than US$1 a day.

[15] There are many small-scale fisheries in developed countries, but this article examines only small-scale, artisanal and subsistence fishing communities in developing countries that are engaged in marine and inland capture fisheries.

[16] Surveys completed 20 years apart by N. Jodha in two villages in Gujarat, India, found that households with real per capita incomes that had declined by more than 5 percent were, on average, better off according to 37 of their own 38 criteria of well-being (R. Chambers. 1989. Editorial introduction: vulnerability, coping and policy. *IDS Bulletin*, 20[2]).

[17] FAO. 2002. *Literature review of studies on poverty in fishing communities and of lessons learned in using the sustainable livelihoods approaches in poverty alleviation strategies and projects*, by G. Macfadyen and E. Corcoran. FAO Fisheries Circular No. 979. Rome.

events such as yearly and seasonal fluctuations in stock abundance, poor catches, bad weather and such natural disasters as cyclones and hurricanes; economic factors such as market price fluctuations and variable access to markets; and the dangers of working at sea. People in small-scale fishing communities may also be vulnerable to poor health and other wider determinants of poverty. There is an important need to improve the understanding of what makes fishers vulnerable to events and factors that result in poverty, what makes it difficult to improve livelihoods, and what potential solutions exist. Unfortunately, studies suggest that vulnerability appears to be increasing among the poor in small-scale fishing communities.

In developing countries, many millions of people live in small-scale fishing communities. While it is now acknowledged that not all small-scale fishers can be assumed to be poor, a large proportion of them are, and remain so, despite the efforts of donor agencies, national and local governments, non-governmental organizations (NGOs) and the communities themselves. Reasons for continuing poverty include factors from within and outside the fisheries sector: vulnerability, as already discussed; insecure access to resources; tendency to resource depletion; the remoteness of many fishing communities; the agro-ecological characteristics of nearby land; low socio-economic, cultural and political status; a lack of political and financial support (often as a result of an emphasis on semi-industrial and industrial fishing); and competition and conflict with industrial vessels and other economic sectors in coastal areas.

Despite the difficulties of measuring poverty in small-scale fishing communities and of defining who is a fisher (as fishers farm, and farmers fish) and what is a fishing community, some crude estimates of the numbers of income-poor fishers can be proposed as shown in Box 9, which suggests that 5.8 million, or 20 percent of the world's 29 million fishers, may be small-scale fishers earning less than US$1 a day.[18] The income-poor in related upstream and downstream activities, such as boatbuilding, marketing and processing, may be as many as 17.3 million people. These figures suggest an overall estimate of 23 million income-poor people, plus their household dependents, relying on small-scale fisheries.

[18] Note that no information is provided on what can be bought in different regions of the world for US$1.

POSSIBLE SOLUTIONS

Poverty eradication strategies must be well focused, but need to acknowledge that economic factors are not the only determinants of poverty, which also include social, cultural and political variables. Understanding these determinants is crucial to the design and implementation of effective solutions.

It can often be difficult to help poor people to come out of poverty because of their poor health, illiteracy, lack of time and aversion to risk. Poor people's lack of influence and power is an especially important problem, and necessitates trying to identify win-win solutions that are in the interests, not only of the poor, but also of the rich, the élite and the powerful.

The World Bank suggests that "without economic growth there can be no long-term poverty reduction", citing the experience of the last decade. Between 1990 and 1999 those regions of the world with the fastest economic growth made the most gains in terms of reducing the numbers of people living on less than US$1 a day. In regions that experienced economic contraction, the numbers of income-poor increased. However, without concerted efforts to redistribute the wealth from economic growth, the gap between rich and poor is likely to widen.

Solutions outside the fisheries sector can be as important, if not more so, than strategies employed within the sector, so action and coordination across sectors may be required.

Strong economic performance in a country, especially of labour-intensive sectors, is important for small-scale fishing communities because it can create alternative employment opportunities – which are vital given the current levels of resource exploitation and the large numbers of people involved in fishing. Diversity and mobility are key livelihood strategies for the poor.

Increases in general economic performance and diversification not only offer the potential for some fishers to leave fishing, thus benefiting those who remain, but also create a wider range of opportunities and possible strategies for contributing to the household livelihoods of those who remain. This appears to have occurred in Malaysia, for example, which is one of the few developing countries in which the number of fishers showed a decreasing trend in the 1990s. Increases in general economic performance also provide opportunities to improve health services, education, public service delivery (such as the provision of roads and, thus, access to markets), governance, political stability and safety nets, all of which are likely to help with poverty alleviation in small-scale fishing communities. Even where there is little economic growth, there is still scope for progress towards poverty alleviation if policy-makers address these issues. A notable and often cited example is the Indian State of Kerala, which has achieved very high levels of social attainment (education, health, longevity) and a low incidence of poverty, even though economic growth has been limited and per capita income remains low.

Solutions within the fisheries sector: As there is little scope for the further expansion of capture fisheries, given the current levels of exploitation, it is crucial to manage fish resources so as to avoid further resource depletion. Effective and flexible management can improve incomes by limiting entry to the coastal fisheries, avoiding wasteful investments and overcapitalization, and supporting sustainable exploitation practices. It can also improve incomes for the poor by effectively protecting small-scale fishers from the activities of large-scale industrial vessels, thereby enlarging the resource base that the poor can exploit.

There are many different types of fisheries management regime, including unregulated common property (i.e. de facto open access), regulated common property (in which regulation ranges from weak to strong) and regimes that seek to use private property rights as a management tool. A particular management regime and its related regulations can have a significant influence on poverty, as can the governance framework and institutional arrangements that determine the distribution of wealth. Management regimes must therefore be appropriate for each specific context and must be enforced effectively so as to contribute to poverty alleviation in small-scale fishing communities.

Community management and, perhaps even more so, co-management (the sharing of power and responsibility between government and the resource user, e.g. small-scale fishers) offer promising solutions to poverty alleviation, although collective action and co-management can require many years of capacity building before they are effective. Box 10 provides an example of successful co-management in Côte d'Ivoire.

The importance of alternative employment opportunities has already been stressed. Aquaculture is often suggested as an obvious alternative to capture fisheries but, although it does have potential, there may be constraints that prevent poor capture fishers from moving into aquaculture. Such constraints may include high capital costs, a lack of suitable sites and a lack of access to land and water for the poor. Marine-based (eco-)tourism provides another possible alternative that is generating interest in many countries.

Development assistance has often been found to be particularly effective when it supports women in post-harvest and value-added activities, because they often show greater desire and ability to save and contribute to the enhancement of household assets than men do. Given that managerial ability and skill are key determinants of the success of individual fishing operations, interventions that upgrade management and skills and address dynamic entrepreneurship may be especially likely to have an impact on poverty in fishing communities.

The following solutions to poverty alleviation within the fisheries sector are also worth mentioning:

- Reducing/removing subsidies on production inputs may lead to the use of smaller boats and engines, reduced expenditure on fuel and

increased expenditure on labour. In the long term, this should increase profits, create more employment and income for poor fishers and reduce debt. The removal of subsidies to large-scale fishing operations and related infrastructure would also remove market distortions that often disadvantage small-scale fishers. However, short-term social considerations are often more important than long-term ones, so subsidies remain.

- Support must be provided for both *ex-ante* risk management and the *ex-post* coping mechanisms that are used to deal with shocks and stresses, while noting that strategies to reduce vulnerability may need to be different from those aimed at reducing poverty.
- Support for effective organizations in fishing communities (e.g. cooperatives, political lobbying groups and social support groups) can be of benefit to the poor in terms of increasing access to credit, effecting policy change in favour of the poor and reducing vulnerability. Such organizations are most beneficial when: governments are supportive and enabling, rather than constraining or restrictive; fishers identify strongly with the aims and motivations of the organizations concerned; and there is able leadership within fishing communities.

RECENT ACTIONS

Considerable work is now being undertaken to improve the understanding of whom and where the poor are, why they are poor and what mechanisms are most effective for poverty reduction. This explains the increasing importance of poverty mapping, the development of poverty assessment methodologies and the emphasis on well-being and capabilities (rather than on income alone), which focus on sustainable livelihoods. However, few such analyses have been carried out in fishing communities.

Recent activities outside the fisheries sector. Several of the poorest developing nations have developed, or are in the process of developing, Poverty Reduction Strategy Papers (PRSPs) jointly with the World Bank and the International Monetary Fund (IMF). Although few of these currently focus specifically on fisheries, they are likely to be of help where fisheries are identified as a key economic sector or, more generally, where strategies to reduce poverty are in place and small-scale fishers are poor.

Recent debt relief to heavily-indebted poor countries (HIPC), accompanied by efforts to improve health, education and other social services, should also be of benefit to small-scale fishing communities.

Bilateral assistance is focusing increasingly on poverty reduction and food security. Most donors have now put in place strategies and criteria that seek to ensure that their assistance is reaching the poor.

Recent activities within the fisheries sector include those carried out by civil society, donor agencies and national governments.

NGOs and civil society continue to work with local fishing communities to reduce poverty through credit, retraining and alternative employment creation programmes and through support for fishing-related and social organizations.

The plight of fishers and their vulnerability to AIDS were reviewed at a recent meeting organized by the Asian Fisheries Society and the International Centre for Living Aquatic Resources Management (ICLARM).[19]

National governments are becoming increasingly involved in both co-managing the control of industrial vessels' activities in waters where small-scale fishers operate and ensuring fairer international access agreements. There is also a growing realization that many small-scale fisheries need to be restructured. The Philippines offers an example of some degree of success in the government's implementation of a governance model that is based on community management systems. A much broader approach to poverty alleviation in fishing communities is

[19] M. Huang. In press. HIV/AIDS among fishermen: vulnerability of their partners. In *Proceedings of the Global Symposium on Women in Fisheries*, (Sixth Asian Fisheries Forum), Kaohsiung, Taiwan Province of China, November 2001, Asian Fisheries Society and ICLARM, World Fish Centre.

BOX 9

Global estimates of income-poor small-scale fishers and related employment in marine and inland capture fisheries

Assumptions:

1. Overall figures for the numbers of fishers are based on 1990 FAO data.
2. Marine deep sea fishers and those engaged in aquaculture are excluded, along with all those in North America and Europe.
3. The percentage of total fishers and those engaged in related employment who are estimated to be income-poor is based on the *World Development Report 2000/1* figures for the share of the population in each region in 1998 that was living on less than US$1 a day, i.e. it is assumed that the level of poverty in fisheries is the same as it is in other sectors.
4. There are assumed to be three people in related jobs for every one fisher.
5. One hundred percent of all inland fishers are assumed to be small-scale, while 90 percent of all marine coastal, unidentified marine and unspecified fishers are assumed to be small-scale.

Sources: FAO 1990 data on total number of world fishers and World Bank. 2000. *World Development Report 2000/1*. Washington, DC.

Poverty in small-scale fisheries communities

	Africa	South America	Asia	Oceania	Former USSR	Total
% of population on < US$1 a day	46.3%	15.6%	25.6%	11.3%	5.1%	
Inland	279 598	2 583	514 023	0	0	796 203
Marine coastal	112 119	10 148	95 837	458	1 331	219 892
Marine other	112 875	43 867	551 133	13 515	0	721 390
Unspecified	320 733	40 716	3 660 428	0	0	4 021 876
Total	**825 325**	**97 313**	**4 821 421**	**13 972**	**1 331**	**5 759 362**
Number of related income-poor jobs	2 475 974	291 940	14 464 262	41 916	3 993	17 278 087
Total income-poor	**3 301 299**	**389 254**	**19 285 683**	**55 889**	**5 324**	**23 037 449**
World population on < US$1 a day						1 198 900 000
fishers as % of world population on < US$1 a day						1.9%

being tried out in 25 West African countries by the Sustainable Fisheries Livelihoods Programme (SFLP), which is funded by the United Kingdom and implemented by FAO. SFLP also supports policy-oriented normative activities such as the development of guidance materials for poverty reduction policies in fisheries.

OUTLOOK

The international community now shares a vision that makes poverty reduction a priority objective. It is becoming clear, however, that this objective is more difficult to achieve than was previously thought and that it requires special strategies and targeting.

BOX 10
Fisheries co-management in Aby Lagoon, Côte d'Ivoire

Fisheries co-management in Aby Lagoon arose out of a crisis caused by stock depletion, misguided external support, the inability of the fisheries administration to implement satisfactory management measures and the desire of both government and resource users to reduce conflicts between the state and resources users. Co-management has contributed to improving livelihoods and poverty alleviation through increased production and greater value of products and through investments in non-fisheries activities. There is a new sense of empowerment and self-respect in the community, and greater security from better access to resources and supportive social networks.

Source: B. Satia, O. Njifonju and K. Angaman. 2001. Fisheries co-management and poverty alleviation in the context of the sustainable livelihood approach: a case study in the fishing communities of Aby Lagoon in Côte d'Ivoire. Paper presented at the CEMARE-organized international workshop, DFID/FAO Sustainable Livelihoods Programme, at Cotonou in November 2001.

Given the importance of overall economic performance, the expected expansion of the world economy can be viewed positively, as can an improving balance of external debt in HIPC. However, questions remain about whether this overall growth will be sustained, whether it will be reflected in developing countries, whether small-scale fishing communities will benefit, and whether the gap between the rich and the poor can be narrowed.

It is promising that the weaknesses of many conventional centralized fisheries management regimes are being increasingly recognized and tackled, when public resources permit. There is a growing awareness of the need for a process approach to fisheries management (accompanied by capacity building and reform) that is participatory and flexible enough to adapt to changing conditions. Co-management and community management arrangements offer some potential in this regard.

Greater awareness that good governance (by administrators, politicians, local élite groups, fishers and scientists) lies at the heart of many of the solutions to poverty in small-scale fishing communities is vital. However, despite this realization, improving governance and the institutional capacity to effect meaningful change in the poverty status of small-scale fishing communities is still a formidable challenge, even though at least it is a challenge that is now being embraced.

Without outside assistance, poverty status in the small-scale fisheries sector can improve only slowly. Improved governance paradigms and capable management institutions are needed, and they will not become effective unless public resources are provided – at least in an initial stage. Although there is a growing realization of this need in concerned milieus, it is still not clear what action such realization will lead to.

ANTIBIOTIC RESIDUES IN AQUACULTURE PRODUCTS

THE ISSUE

Background. As in other animal production sectors, antibiotics are used in aquaculture during both production and processing, mainly to prevent (prophylactic use) and treat (therapeutic use) bacterial diseases.[20] Antibiotics have also been recommended and used as disinfectants in

fish handling, but this practice has proved to be ineffective and is generally not approved by the fish inspection services. Antibiotics have not always been used in a responsible manner in aquaculture and, in a number of reported situations, control of the use of antibiotics has not provided a proper assurance of the prevention of risks to humans. FAO, the World Health Organization (WHO), the International Office of Epizootics (OIE) and a number of national governments have already raised the issue of irresponsible use of antibiotics in all production sectors, with particular concern for the potential risks to public health. Many governments around the world have introduced, changed or tightened national regulations on the use of antibiotics, in general and within the aquaculture sector.

Public health concerns. When consumed directly by humans as medicine, antibiotics may cause adverse side-effects, but these can generally be avoided through adhering to the recommended dose and duration of therapy. However, when antibiotics are unintentionally ingested as residues in food, the amount ingested cannot be quantified or monitored and may cause direct health concerns, such as aplastic anaemia, which is said to be associated with chloramphenicol. These direct effects pose significant risks to human health. In addition, the unintentional consumption of antibiotics is leading to the development of antibiotic resistance in bacteria that are pathogenic to humans, and this is another important problem that has not yet received adequate attention. The development of antibiotic resistance by pathogenic bacteria is considered to be one of the most serious risks to human health at the global level.[21] The problem arises when bacteria acquire resistance to one or more of the antibiotics to which they were formerly susceptible, and when that resistance eventually makes the antibiotics ineffective in treating specific microbial diseases in humans.[22] Recognition of the risks associated with the direct and indirect effects on human health of both active and passive consumption of antibiotics has led to bans on the use of certain antibiotics in animal food production (particularly those antibiotics for which no safe residue levels can be determined) and to the establishment of maximum residue limits (MRLs) for those with known risks.

Effects on the industry. During the last year, the detection of chloramphenicol in internationally traded shrimp products has caused much concern. The substance has been found in cultured products, resulting in a slowdown in imports, causing economic loss among the concerned producers and reflecting negatively on all shrimps and on aquaculture overall.

POSSIBLE SOLUTIONS

There are two strategies for achieving acceptable levels of antibiotic residues in aquatic products: limiting the use of antibiotics in aquaculture enterprises; and establishing and enforcing MRLs in aquaculture products. Both strategies must be used.

Limiting the use of antibiotics. Antibiotics are necessary for specific and identified uses in aquaculture. Regulation of their commercial availability is one of the ways to ensure that they are used responsibly in aquaculture.

There are several possible strategies for limiting

[20] See, for instance: FAO/SEAFDEC/CIDA. 2000. *Use of chemicals in aquaculture in Asia*, edited by J.R. Arthur, C.R. Lavilla-Pitogo and R.P. Subasinghe. Proceedings of the Meeting on the Use of Chemicals in Aquaculture in Asia, Iloilo, the Philippines, 20–22 May 1996. 235 pp.; and FAO. 1997. *Towards safe and effective use of chemicals in coastal aquaculture*. Reports and Studies, GESAMP No. 65. Rome. 40 pp.

[21] Updated information on the development of microbial resistance can be found at: www.fda.gov/oc/opacom/hottopics/anti_resist.html. See also: K.M. Cahill, J.A. Davies and R. Johnson. 1966. Report on an epidemic due to *Shigella dysenteriae*, type 1, in the Somali interior. *American Journal of Tropical Medicine and Hygiene*, 15: 52–56.

[22] P. Shears. 2001. Antibiotic resistance in the tropics. *Transactions of the Royal Society of Tropical Medicine and Hygiene*, 95: 127–130. F. Angulo and P.M. Griffin. 2000. Changes in antimicrobial resistance in *Salmonella enterica* serovar *typhimurium. Emerging Infectious Diseases*, 6(4); and USFDA. 1997. Extralabel animal drug use; fluoroquinolones and glycopeptides; order of prohibition. *Federal Register*, 62(99): 27 944–27 947.

TABLE 10
Possible purchase and user patterns and resulting residual effects of antibiotics in aquaculture

Type of antibiotic	Purchase and use	Residues in fish
Antibiotics specifically approved for aquaculture use ("label use")	"Over the counter" On prescription	Within the levels established by regulatory authorities
Antibiotics to be used under "Extra-label use"[1]	Of approved antibiotics for aquaculture (on professional prescription)	Within the levels established by regulatory authorities
Antibiotics to be used in emergencies and for research	Temporary use and only following specific approval by qualified professionals	No residues in commercialized products, or within the levels established by regulatory authorities
All other antibiotics	Prohibited	Absent

[1] Extra-label use is defined as "use of a drug in an animal in a manner that is not in accordance with the purpose approved on the label".

the commercial availability of antibiotics. The two most basic are: identifying the permitted antibiotics (and their MRLs) and prohibiting all others, or identifying the prohibited antibiotics and permitting all others. The first strategy is clearly more in line with the precautionary approach.

A possible scheme for limiting the use of antibiotics by using the first basic strategy is outlined in Table 10.

Establishing and enforcing MRLs. In the twelfth edition of the Procedural Manual of the Codex Alimentarius Commission (CAC),[23] the maximum limit for residues of veterinary drugs (MRLVD) is defined as "the maximum concentration of residue resulting from the use of a veterinary drug (expressed in mg/kg on a fresh weight basis) that is recommended by the Codex Alimentarius Commission to be legally permitted or recognized as acceptable in or on a food."

The MRLVD is based on the type and amount of residue considered to be free from any toxicological hazard for human health, as expressed by the acceptable daily intake (ADI) or by a temporary ADI that utilizes an additional safety factor. The MRLVD also takes into account other relevant public health risks, as well as food technological aspects. When establishing an MRL, consideration is also given to residues of the same drug that occur in food of plant origin and/or in the environment. Furthermore, the MRL may be reduced so as to be consistent with good practice in the use of veterinary drugs, and to the extent that practical analytical methods are available.[24]

RECENT ACTIONS

Limiting the use of antibiotics in aquaculture. Some countries or regions, such as the EC, Canada and Norway, approve a limited number of antibiotics specifically for use in aquaculture. In Canada, the antibiotics approved for aquaculture use are: oxytetracycline, sulfadiazine (trimethoprim), sulfadimethoxine (ormetoprim) and florfenicol.[25] Not only do the regulations approve the types of antibiotic that can be used, they also usually specify the species, diagnosis, dose, duration and withdrawal period to be

[23] CAC is a joint commission formed by FAO and WHO. Since the first steps were taken in 1961 to establish a Codex Alimentarius (food code), CAC, as the body charged with developing that code, has drawn world attention to the field of food quality and safety. CAC is charged with developing food safety standards for worldwide application, and Codex standards have become the benchmarks against which national food measures and regulations are evaluated within the legal parameters of the World Trade Organization's Sanitary and Phytosanitary Agreement (WTO/SPS).

[24] CAC Procedural Manual twelfth edition can be found at: ftp://ftp.fao.org/codex/manual/manual12ce.pdf

[25] Details of antibiotics approved for aquaculture use in Canada can be found at: http://salmonhealth.ca/therapeutant-sapproved.html

observed when an antibiotic is used as a therapeutic agent. Compliance with these conditions and regulations assures that the residues in products are kept below the MRLs and that the risk of pathogenic bacteria developing resistance is negligible or, at least, acceptable.

Chloramphenicol is still an authorized antibiotic in human medicine. Patients who use it as a medicine are taking a risk, but it is a risk that they can (and should) assess and understand fully. In addition, a course of treatment with chloramphenicol should only be followed under the direct supervision of a qualified physician. Chloramphenicol ingestion through the consumption of fish products containing residues, however, could pose health hazards to humans, which could have serious implications. This is why chloramphenicol is authorized for use in human medicine, but not for veterinary applications.

Until 1994, the EC's MRL for chloramphenicol was 10 ppb as a provisional (Annex III) allocation. After 1994, when it became clear that data to demonstrate a safe level of chloramphenicol could not be established, the MRL was changed to zero (Annex IV). The detection limits for chloramphenicol by the accepted testing methodology using high-performance liquid chromatography (HPLC) was then 5 to 10 ppb. Thus, effectively, the MRL for chloramphenicol became 5 ppb. Over the past two years, several tests for chloramphenicol based on enzyme linked immunosorbent assay (ELISA) technology have come on to the market. The stated manufacturer's detection threshold for chloramphenicol using these ELISA-based tests is 0.05 ppb. Since the EC does not recognize an MRL for chloramphenicol (zero tolerance), by using more sensitive tests, analytic chemists have disqualified many of the food items that previously had been accepted as safe for human consumption.

There are nine substances included in Annex IV of Regulation 2377/90/EEC that may not be used in food producing species because no safe level of residue can be determined: chloramphenicol,[26] chloroform, chlorpromazine, colchicine, Dapsone, Dimetridazole, Metronidazole, nitrofurans (including Furazolidone) and Ronidazole. The presence of an Annex IV substance residue (including metabolites) is prima facie evidence of the use of a prohibited substance in a food animal species.

In the United States, several drugs are prohibited for extra-label animal and human drug uses in food producing animals. Those relevant to aquaculture interests include: chloramphenicol, Dimetridazole, Furazolidone (except for approved topical use), Nitrofurazone (except for approved topical use) and fluoroquinolones.

Approved antibiotics can be bought and utilized under two conditions: over the counter, or on prescription by a qualified professional. In Canada, the over-the-counter purchase of oxytetracycline is supported by the existence of a Medicating Ingredient Brochure, which recommends the conditions for its use. It is important that information on the responsible and correct use of antibiotics be provided to aquaculturists. In developed countries (e.g. the United States, EC countries, Canada), most approved antibiotics can only be purchased and utilized on prescription, and under the guidance of a qualified professional.[27]

For extra-label use, a qualified professional may write a prescription for the use of an approved antibiotic under conditions that vary from those approved. In this case, the approving officer will provide specific instructions for the antibiotic's use and is responsible for its application. Under the Canadian regulations, the qualified professional assumes full responsibility for any drug residue violation. Under the United States regulations, there is provision for authorizing licensed veterinarians to prescribe extra-label uses of antibiotics in animal production for drugs that have been approved for

[26] See: www.emea.eu.int/pdfs/vet/mrls/chloramphenicol.pdf

[27] Laws define which qualified professionals are authorized to write drug prescriptions for the treatment of fish in aquaculture and are responsible for controlling them. Such professionals may have different professional backgrounds in different countries; for instance, in the EC and the United States, they are veterinarians (with proper aquaculture training), but in some countries they could be biologists (aquaculture) with proper training in fish medicine and human public health.

human use only. However, the same regulation provides that the United Stated Food and Drug Administration (USFDA) "may prohibit an extra-label drug use in animals if, after affording an opportunity for public comment, the agency finds that such use presents a risk to the public health". This regulation establishes, de facto, a large difference from those countries that allow only the use of approved antibiotics for aquaculture.

This could create situations of lack of control. As expressed by USFDA, "the data and information necessary to determine, in particular situations, whether the resistance level at time of slaughter would be increased above normal as a result of extra-label use is not generally available to practising veterinarians, who must make the extra-label use decisions". In addition to antibiotic residues, therefore, the increased resistance to the specific antibiotic should, in principle, also be monitored. In countries that do not have an effective veterinary service competent in aquaculture or that lack microbiological monitoring, the extra-label use of antibiotics implies irresponsibility and a serious shortcoming in the management of risks to human health.

There are also provisions regarding the use of antibiotics to deal with emergencies (e.g. epidemics) and research. In general, banned antibiotics and banned veterinary drugs pose significant demonstrable risks to human health. Box 11 provides a list of the antibiotics and veterinary drugs that are currently banned in the United States. Banned antibiotics and veterinary drugs may vary from country to country.

Establishing and enforcing MRLs. The procedures by which CAC sets MRLVDs are complex and, owing to the inevitable international involvement, slow. Data are analysed by the Joint FAO/WHO Expert Committee on Food Additives (JECFA), which meets only once a year. When a recommendation is reached (after much JECFA consideration), the conclusions are passed to CAC's own expert committee, the Codex Committee on Residues of Veterinary Drugs in Food (CCRVDF), for further evaluation.[28]

Establishing MRLs for fish presents several problems, including the identification of what are edible tissues and the complex pharmacokinetic properties and metabolism of veterinary drugs in fish. The only full CAC MRLs for aquaculture species listed in the database are for the administration of oxytetracycline at 100 µg/kg to "fish" and "giant prawn", but several additional MRL proposals from JECFA are now within the CAC system. From this it is clear that it will be many years before CAC sets a usable list of MRLs

[28] A database of CAC MRLs so far developed is available at: apps.fao.org/codexsystem/vetdrugs/vetd_ref/q-e.htm.

BOX 11
Drugs currently banned for use in raising animals in the United States (USFDA 2002)

- Chloramphenicol
- Clenbuterol
- Diethylstilbestrol (DES)
- Dimetridazole
- Ipronidazole
- Other nitroimidazoles
- Furazolidone, Nitrofurazone, other nitrofurans
- Sulphonamide drugs in lactating dairy cattle (except approved use of sulfadimethoxine, sulfabromomethazine, and sulfaethoxypyridazine)
- Fluoroquinolones
- Glycopeptides

Source: www.fda.gov/cvm/index/updates/nitroup.htm

TABLE 11
JECFA proposed MRLs relevant to aquaculture

JECFA Meeting number	Year	Drug	Tissue	Species	MRL (µg/kg)	Status
47	1996	Oxytetracycline	Muscle	Giant prawn *(Penaeus monodon)*	100	
48	1997	Flumequine	Muscle and skin in normal proportion	Trout	500	Temporary
52	1999	Thiamphenicol	Muscle	Fish	50	Re-evaluate in 2002
52	1999	Deltamethrin	Muscle	Salmon	30	
54	2002	Flumequine	Muscle and skin in normal proportion	Trout	500	
58	2002	Oxytetracycline	Muscle	Fish	200	

relevant to aquaculture; national or market-area MRLs will therefore predominate in the protection of consumers within their areas. The products that are being assessed by JECFA are given in Table 11.

As well as the MRLs set by JECFA, several countries or country groups have set their own. The MRLs relevant to aquaculture in the EC European Economic Area (EC EEA) and the United States are given in Tables 12 and 13. The information on MRLs for veterinary drug residues in Canada can be found on the Health Canada Web site: www.hc-sc.gc.ca/english/index.html. Specific MRL information is given at: www.inspection.gc.ca/english/anima/fispoi/manman/samnem/bull8e.shtml.

The Bureau of Veterinary Drugs, Health Canada has approved six drug products (eight drug substances) for use in aquaculture (Table 14). Additional information on amended MRLs is also available at: www.hc-sc.gc.ca/english/media/releases/2002/2002_08bk1.htm (see Table 15).

The British Columbia Ministry of Agriculture also has a valuable Web site with information on aquaculture and, in particular, the use of antibiotics in aquaculture: www.agf.gov.bc.ca/fisheries/health/antibiotics.htm.

Japanese MRL information can be found at: www.ffcr.or.jp/zaidan/ffcrhome.nsf/pages/e-info-foodchem. Only two aquaculture MRLs are posted for fish and shellfish in Japan: 0.2 ppm for oxytetracycline and 0.2 ppm for Spiramycin. Listings published elsewhere suggest that a wide range of veterinary medicines has been approved for use in fish in Japan.

MRLs of approved antibiotics are usually conservative. Processing, cooking and frozen storage can reduce the residual levels of antibiotics.[29] However, data regarding the effect of processing, cooking and freezing aquatic animal products on the degradation of antibiotic residues in aquatic animal products are scarce; it is therefore essential to conduct proper exposure assessments, in the form of risk assessments, not only in order to understand the risks but also to reassure consumers.

In the EC, consumer safety is addressed via MRLs established by Council Regulation EEC/2377/90. The EC definition of MRL is virtually the same as that adopted by CACRVD for foods. The Annexes to Regulation 2377/90 are as follows:

- Annex I: full MRL can be set;
- Annex II: safe, no MRL needed to protect the consumer;
- Annex III: sufficient data to set a provisional

[29] Chun-Chieh Lan, Bau-Sung Hwang and Mei-Feng Tu. 2001. Effect of microwave and roast treatment on the degradation of sulfamethazine residue in tilapia meat. *Journal of Food and Drug Analysis*, 9(2): 102–106.

TABLE 12
Current MRLs relevant to aquaculture in the EC EEA

Drug	Annex	MRL (µg/kg)	Species	Council Regulation
All sulphonamides	I	100	All food producing	
Trimethoprim	I	50	Finfish	
Amoxicyllin	I	50	All food producing	
Ampicillin	I	50	All food producing	
Benzylpenicillin	I	50	All food producing	
Cloxacillin	I	300	All food producing	
Dicloxacilin	I	300	All food producing	
Oxacillin	I	300	All food producing	508/1999/EC
Penethamate	I	50	All food producing	
Sarafloxacin	I	30	Salmonidae	
Chlortetracycline	I	100	All food producing	
Oxytetracycline	I	100	All food producing	
Tetracycline	I	100	All food producing	
Bronopol	II		Salmonidae, eggs only	
Somatosalm	II		Salmon	
Azamethiphos	II			1931/1999/EC
Emamectin benzoate	I	100	Salmonidae	1931/1999/EC
Teflubenzuron	I	500	Salmonidae	1931/1999/EC
Tricaine mesylate	II		Finfish	1942/1999/EC
Toschloramide Na	II		Finfish	2393/1999/EC
Diflubenzuron	I	1000	Salmonidae	2593/1999/EC
Thiopental iv	II	n/a	All food producing	749/2001/EC
Flumeqine	I	600	Salmonidae	2728/1999/EC
Oxolinic acid	III expires 1/1/03	300	Finfish	807/2001/EC
Florfenicol	I	1000	Finfish	1322/2001/EC

Note: **Annex I substances have major species or animal group MRLs allocated. Annex II substances are regarded as consumer-safe and do not require MRLs to be set. Only those Annex II substances that are of relevance to aquaculture are included here. Annex III substances have provisional time-limited MRLs to allow final safety data to be generated.**

TABLE 13
Current tolerances relevant to aquaculture in the United States

Drug	Species	Tolerance (MRL)	Status
Trifluralin	Shrimps or prawns	0.001mg/kg	Temporary
Oxytetracycline	Salmonids	0.2mg/kg	Temporary
Oxolinic acid	Salmon, Pacific	0.01 mg/kg	At LOD[1]

[1] LOD = limit of determination.

TABLE 14
Currently approved drugs and their MRLs in Canada

Drug	Species	Tissue	AMRL[1]
Oxytetracycline	Salmonids Lobster	Edible tissue	0.1 µg/g
Sulfadi-methoxine	Salmonids	Edible tissue	0.1 µg/g
Ormetoprim		Edible tissue Muscle/skin	0.5 µg/g 1.0 µg/g
Sulfadiazine	Salmonids	Edible tissue	0.1 µg/g
Trimethoprim		Edible tissue Muscle/skin	0.1 µg/g 1.0 µg/g
Tricaine methanesulfonate	Salmonids	Edible tissue	0.02 µg/g
Formaldehyde	Salmonids		n/a[2]
Florfenicol	Salmonids	Edible tissue	0.1 µg/g[3]

Notes:
[1] AMRL = administrative MRL.
[2] Regulated biological substance, ubiquitous in nature.
[3] MRL is specified for the metabolite, florfenicol amine.

TABLE 15
Additional amended MRLs in Canada

Drug	Marker residue	MRL (µg/g)	Species
Florfenicol	Florfenicol amine	0.8	Muscle of salmonids (salmon, trout, char, whitefish and grayling)
Sulfadiazine	Sulfadiazine	0.1	Muscle of salmonids (salmon, trout, char, whitefish and grayling)
Trimethoprim	Trimethoprim	0.1	Muscle of salmonids (salmon, trout, char, whitefish and grayling)

MRL, but additional data needed to allocate full MRL;
- Annex IV: on safety grounds, no MRL can be set. Substances placed in this Annex are prohibited from use in food animal species, although they may still be used in pet species.

It should be noted that, although no formal MRL regulation has been established in the United States, the equivalent there is the tolerance, which is established by the regulatory authorities.

GLOBAL PERSPECTIVE

HACCP as a risk-based management tool for antibiotic use in aquaculture. In aquaculture, antibiotics are generally administered in feeds, having been either added during feed manufacture or surface-coated on to pellets by the manufacturer or the farmer. During outbreaks of disease, farmers may apply antibiotics using other routes. Clear instructions are therefore required for the feed manufacturers, antibiotic dealers, veterinary authorities and farmers who are responsible for the use of antibiotics. Who provides such information, and who is responsible for regulating and controlling antibiotics nationally?

The Hazard Analysis Critical Control Point (HACCP) system is recommended as a way of reducing hazards stemming from the processing of fish and fishery products. Implementation of the HACCP system in fish processing is mandatory, and all exporting countries have to comply with this requirement for international trade. Since the middle of 1990, some developed countries have introduced the system to control hazards from the use of antibiotics at the pond level.[30] The introduction of HACCP to control food hazards in aquaculture, including those stemming from the irresponsible use of antibiotics has been widely recommended[31] and has been discussed by an FAO/Network of Aquaculture Centres in Asia-Pacific (NACA)/WHO Study Group on Food Safety.[32]

HACCP is currently not mandated by most primary animal production regulations that include aquaculture. In many countries, even when the liability may be shared or (depending on regulations) when it remains on the production side, the actual obligation to control the use of antibiotics and their residues rests with the processing industry, as HACCP is mandated within the processing sector. This creates difficulties in implementing control measures on antibiotic use in aquaculture.

All the elements for identifying the critical control points (CCPs) and critical limits of regulatory requirements exist for approved antibiotics and veterinary drugs, specific fish or shellfish species, diagnosis (purpose of use), dose, duration of treatment and withdrawal period. It has been suggested that the CCP would be at the feeding stage, since this is when antibiotics are usually introduced into the production process. The analysis of residues of the antibiotics used, and the checking of compliance with regulations, would form part of the verification procedures. In addition, as USFDA has suggested, the monitoring of residues in flesh may be not enough, and the development of resistance in pond micro-organisms (and/or the target micro-organism) should also be monitored – an additional CCP.

Regarding the fish processing industry, further procedures, activities and monitoring should be performed in addition to the HACCP plan. In particular, prerequisites (e.g. plant location, water supply and effluent control) and good hygiene practices at the pond should be implemented. The storage and handling of antibiotics should be put under a scheme of monitoring, as indicated in the United States HACCP-based regulation for storage of chemicals in the plant, for example.[33]

---

[30] G. Valset. 1997. Norwegian hazard controls for aquaculture. *In* R.E. Martin, R.L. Collette and J.W. Slavin. *Fish inspection, quality control, and HACCP*, pp. 392–402. Lancaster, PA, USA, Technomic Publishing.

[31] A. Reilly, P. Howgate and F. Kaferstein. 1997. Safety hazards and the application of the Hazard Analysis Critical Control Point System (HACCP) in aquaculture. *In* R.E. Martin, R.L. Collette and J.W. Slavin. *Fish inspection, quality control, and HACCP*, pp. 353–375. Lancaster, PA, USA, Technomic Publishing. See also: R. Armstrong. International hazard controls in aquaculture, pp. 403–406, in the same work.

[32] WHO. 1999. *Food safety issues associated with products from aquaculture*. Report of a Joint FAO/NACA/WHO Study Group. WHO Technical Report Series No. 883. Geneva. 55 pp.

As with most food hazard-related areas, many people are involved in aquaculture hazard monitoring, including regulators, consumers, producers, processors, journalists and – sometimes – researchers, who may lack a complete picture of a given risk and its possibilities of management. The importance of communicating problems widely has been recognized.[34] Risk communication is a necessary component of antibiotic use for aquaculture purposes. In some countries, there is a considerable lack of information and transparency, which conspires against the proper solution of possible problems, and eventually creates additional ones. Communication with the consumer is particularly important. A crisis, such as the one involving chloramphenicol, alters the national and international fish markets because it fosters consumers' fears about fish as food.

The proper use of approved antibiotics will continue to be necessary in animal production, including aquaculture, and consumers should be reassured that the use of approved antibiotics, in particular under "label use" conditions, does not imply a hazard. In addition to the public health problems that result from people being rendered defenceless to illnesses caused by antibiotic-resistant bacteria and the residues of banned antibiotics, there are also economic constraints to be taken into account.

The future of aquaculture depends, *inter alia*, on the production of safe and wholesome products, and this goal can be achieved. However, the recent crisis with chloramphenicol indicates that the current situation with regard to the use of antibiotics is far from satisfactory. The responsible use of antibiotics can be achieved through implementing adequate risk management measures, including developing and enforcing appropriate regulatory procedures. The information and knowledge base concerning the hazards and risks involved in the use of antibiotics should be improved, and the risks posed by existing hazards, in particular of drug supplies and use, should be communicated. Additional efforts are required in the areas of research, training, capacity building, legal frameworks and communication. Aquaculturists in developing countries should be encouraged always to seek professional guidance in the use of antibiotics, particularly from the regulatory agencies, extension services and qualified professionals. Where there is no adequate professional guidance, countries should embark on developing the necessary capability, and aid agencies and development partners should provide all necessary assistance to this process.

Application of HACCP-based management practices within production systems is central for reducing possible risks. Appropriate guidelines and technical standards should be developed in consultation with all stakeholders. There is also a need to reassure consumers about the safe use of approved antibiotics and measures to constrain the use of banned substances. Relevant information should be made readily available to the general public through various information dissemination mechanisms.[35] Efforts should be made to restrict the use of antibiotics to therapeutic purposes only.[36] Countries should be encouraged to develop and implement more internationally harmonized and transparent procedures for managing and controlling the use of antibiotics in aquaculture.

National or market-area MRLs. National or market-area MRLs will continue to exist until CAC has been able to set MRLs with wide international acceptance. However, the CAC process is slow, so a full range of MRLs will not be available for many years. If there are science-based national or regional MRLs, and the control procedures are based on reasons of consumer safety, claims that trade barriers exist will be unsupportable, provided that the residue control programmes are operated fairly and equivalently between national and imported products.

---

[33] USFDA. 21 CFR Parts 123 and 124.

[34] E. Spencer Garrett, C. Lima dos Santos and M.L. Jahnke. 1997. Public, animal and environmental health implications of aquaculture. *Emerging Infectious Diseases*, 3(4).

[35] www.anmv.afssa.fr/oiecc/documents/recommendationsconf.pdf; and www.anmv.afssa.fr/oiecc/documents/recommendations_hanoi.pdf

[36] http://europa.eu.int/rapid/start/cgi/guesten.ksh?p_action.gettxt=gt&doc=IP/02/466|0|RAPID&lg=EN&display=