

EUROPEAN INLAND FISHERIES ADVISORY COMMISSION

Report and Proceedings of the

**SYMPOSIUM ON AQUACULTURE DEVELOPMENT – PARTNERSHIP
BETWEEN SCIENCE AND PRODUCER ASSOCIATIONS**

Wierzba, Poland, 26–29 May 2004

held in connection with the

**EUROPEAN INLAND FISHERIES ADVISORY COMMISSION
TWENTY-THIRD SESSION**

Wierzba, Poland, 26 May–2 June 2004



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PREPARATION OF THIS DOCUMENT

A Symposium on Aquaculture Development – Partnership between Science and Producer Associations was organized from 26 May to 29 May 2004 in conjunction with the Twenty-third Session of the European Inland Fisheries Advisory Commission (EIFAC) in Wierzba, Poland. The Symposium was convened by Mr L. Váradi (Hungary) and chaired by Mr K. Goryczko (Poland) and was attended by 72 participants from 23 countries.

In its first part this document contains the Report of the Symposium which was presented to and approved by the Twenty-third Session of EIFAC. The Proceedings of this Symposium, presented in the second part of this document, were edited and finalized by Mr M. New and Mr L. Váradi. In consultation with the members of the editorial board, Ms S. Stead, Mr M. Ciesla and Mr C. Hough, fourteen experience papers have been selected for publication in these proceedings. The topics of these selected papers were considered the most relevant to the main theme of the Symposium.

Distribution:

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FAO European Inland Fisheries Advisory Commission.

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ABSTRACT

The Symposium on Aquaculture Development – Partnership between Science and Producer Associations was held in Wierzba, Poland, from 26 May to 29 May 2004 in concomitance with the Twenty-third Session of the European Inland Fisheries Advisory Commission (EIFAC). The Symposium was attended by 72 participants from 23 countries. Five invited papers, 37 experience papers and three posters were presented. The Symposium considered existing and possible partnerships and collaboration between aquaculture producers and scientists, government officials and other stakeholders. The Symposium further addressed opportunities and needs of aquaculture producer associations, and identified measures and recommendations to strengthen participation, activities and positions of aquaculture associations in the management and development of the aquaculture sector in Europe. In addition to the report of the Symposium, this document contains the Symposium proceedings which commence with a review of the key elements from five invited papers presented by representatives of the European Commission (EC), the Federation of European Aquaculture Producers (FEAP), the European Aquaculture Society (EAS), Aquaculture Technology and Training (AquaTT) and the Network of Aquaculture Centres in Asia-Pacific (NACA). Fourteen selected experience papers, presented by authors from France, Germany, Hungary, Italy, the Netherlands, Poland, Romania, the Russian Federation, Turkey and the United Kingdom of Great Britain and Northern Ireland, cover, *inter alia*, aquaculture, conservation, cooperation, economic transition, ecotourism, education, fisheries, management, planning, partnerships, policy, producers associations, product chains, recirculation, risks, stakeholder participation, sustainability and the role of science.

Key words: Aquaculture, Producers Associations, Science, EIFAC, European Inland Fisheries Advisory Commission, Europe

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REPORT OF EIFAC SYMPOSIUM ON AQUACULTURE DEVELOPMENT – PARTNERSHIP BETWEEN SCIENCE AND PRODUCER ASSOCIATIONS

INTRODUCTION

1. A Symposium on Aquaculture Development – Partnership between Science and Producer Associations was organized from 26 May to 29 May 2004 in conjunction with the Twenty-third Session of EIFAC in Wierzba, Poland. The Symposium was convened by Mr L. Váradi (Hungary) and chaired by Mr K. Goryczko (Poland) and was attended by 72 participants from 23 countries. The Symposium benefited from the participation and experience of the Federation of European Aquaculture Producers (FEAP¹) and the European Aquaculture Society (EAS²). The main documentation comprised five invited papers and 37 experience papers and three posters.

2. In his introduction to the Symposium, Mr Váradi referred to the objectives and major thematic areas of the Symposium, which were:

- (i) To make a broad assessment of the present roles, opportunities and needs of aquaculture producer associations in the EIFAC region.
- (ii) To identify the possible contributions by other stakeholders, including in particular, research institutions (natural and social sciences) and government agencies, in support of aquaculture producer associations.
- (iii) To propose measures to strengthen participation, activities and positions of aquaculture associations in the management and development of the aquaculture sector.

The major themes were:

- Promotion and definition of research and technology development programmes.
- Human resource development, capacity building and education.
- Promotion of efficient use of resources.
- Comprehensive policies, supportive legal and institutional frameworks based on communication and consultation with the producers as the major stakeholders.
- Enhanced partnership, participation and consultation of all stakeholders in the planning, development and management of aquaculture.
- Development of investment incentives, market studies, product marketing programmes and consumer awareness campaigns.

3. With specific reference to partnerships between science and producer associations, participants were invited to consider and discuss major issues, experiences, and challenges in such partnerships, as well as opportunities and measures for improvements with a view to formulating findings, conclusions and recommendations by the Symposium.

SESSION 1: INVITED PRESENTATIONS

4. The activities of the European Union (EU), the Federation of European Aquaculture Producers (FEAP), the European Aquaculture Society (EAS), the AquaFlow³ and AquaTT⁴

¹ Federation of European Aquaculture Producers (FEAP): www.feap.info; www.aquamedia.org

² European Aquaculture Society (EAS): www.easonline.org

³ AquaFlow : www.aquaflow.org

⁴ AquaTT: www.aquatt.ie

programmes and Asian experiences demonstrate the wide range of issues associated with interactions between the scientific and production sectors.

5. The European Community adopted a strategy⁵ for the sustainable development of the European aquaculture industry in September 2002 that is now being implemented. The strategy aims to maintain the competitiveness, productivity and sustainability of the aquaculture sector. It also aims to enlarge the knowledge base of the industry, so appropriate partnerships should be promoted at all levels, particularly between science and industry. Cooperatives, trade associations and producer organizations/associations are essential mechanisms, not only to improve marketing but also to cover R&D costs that many small farms cannot afford.

6. In the past, the European Commission has contributed to strengthening the links between the aquaculture industry and scientists by promoting participation of the industry in research projects and concerted action to disseminate project results through AquaFlow, and by identifying research needs of the aquaculture sector through PROFET⁶. The Sixth Framework Research Programme offers new possibilities to scientists and producer associations to improve their partnerships under the specific measures for small- and medium-size enterprises (SMEs). In addition, the FIG (Financial Instrument for Fisheries Guidance) regulation has been modified to allow the financing of small-scale applied research initiatives. The European Commission strongly recommends producers and scientists make use of the instruments that exist at community level.

7. Targeted research and development programmes have significant benefits for aquaculture producers. The FEAP and its members have benefited from a wide range of research programmes supported by the European Commission. In recent years, initiatives have focused increasingly on broader issues such as food safety and environmental improvement. Collaborative research programmes with strong participation of and ownership by producers are of special interest to the European aquaculture sector, where the producers are often required to contribute financially to research projects. Programmes such as the Sixth Framework Programme, Financial Instruments for Fisheries Guidance (FIG) and the Cooperative Research in Aquaculture and Fisheries Technology (CRAFT) with Industrial Associative Groupings (IAG) can provide support for on-site/on-farm research which is often combined with training and dissemination activities.

8. The participation of the professional aquaculture sector in Research, Technology and Development (RTD) programmes is generally driven by its interest in accessing new, economically efficient developments in technology. The main reasons that producers do not participate in such programmes are that they are unaware of the possibilities of such programmes and that they fear administrative complications. Overall, successful partnerships are characterized by good understanding and communication between partners, clear comprehension of their needs and pro-active positions, as well as coherent national and European RTD policies.

9. The AquaFlow network disseminates information on the results and progress of research and technological development programmes funded by the European Union (EU) and

⁵ Communication from the Commission to the Council and the European Parliament referring to a Strategy for the Sustainable Development of European Aquaculture (September 2002)

http://europa.eu.int/comm/fisheries/reform/aquaculture_en.htm,

http://europa.eu.int/comm/fisheries/doc_et_publ/factsheets/legal_texts/docscom/en/com_02_511_en.pdf

⁶ PROFET transnational workshops on research needs of the European fish farming sector:

www.feap.info/news/RTD/profet_en.asp

nationally. It provides aquaculture producers, decision-makers, administrators, researchers and producer representatives with concise and up-to-date overviews on aquaculture RTD information. It also encourages use of advanced information technologies, including e-mail and the internet, for the transfer of information and the promotion of contacts. Surveys confirmed the active participation of producers in RTD programmes, the very significant demand for RTD information and the expected benefits, such as technological improvements, increased competitiveness, enhanced personnel skills and improved economic returns.

10. While information sourcing and translation can be costly, willingness to pay for RTD information is varied. AquaFlow efforts on the identification and dissemination of RTD information are effective but should be enhanced by regional initiatives such as the Professional Needs in Aquaculture Research (PROFET) workshops. It was considered equally important that RTD activities be conducted at national level and in languages appropriate to the region.

11. Aquaculture Technology and Training (AquaTT), a European network for training and technology transfer in the aquaculture industry, works as an aquaculture industry education and training service provider. One of its major focuses is the recognition and accreditation of European aquaculture qualifications using a competency based approach in the WAVE⁷ (Working in Aquaculture Validation of Experience) initiative. Other activities include promotion of aquaculture to the general public, promotion of the role of women in aquaculture, networking of students and the development of new training materials. Aquamedia is another source of information on European aquaculture.

12. Surveys of aquaculture producer associations in Asia, conducted by the Network of Aquaculture Centres in Asia-Pacific (NACA⁸), showed the wide range of approaches and purposes, and organizational and working patterns adopted by such associations. These also displayed different levels and modes of representativeness, independence, participation and consultation, empowerment and policy influence. Key issues include communication and cooperation with governments, scientific institutions and other parties, as well as supportive legislation and enabling environments facilitating and promoting such associations.

13. It was recognized that producers, in particular small-scale farmers, should be assisted in the organization of truly representative associations. They should also participate in priority-setting and decision-making processes and be provided with access to information, and training and education to enhance their skills. In some European regions such assistance, including advice and capacity-building in scientific, technical, financial and economic aspects of aquaculture is required. In this context it was noted that the recently established Network of Aquaculture Centers in Eastern Europe (NACEE) now includes research institutes and universities in 12 Eastern European countries.

SESSION 2: PARTNERSHIP EXPERIENCES BETWEEN SCIENCE AND PRODUCER ASSOCIATIONS

14. Producer associations and producer organizations have existed since early in the nineteenth century and have responded to changing production methods, markets and economic systems that have placed increasing pressure on smaller producers.

15. Producer associations and organizations are characterized as follows:

⁷ WAVE: <http://www.aquatt.ie/aquattinitiatives/currentinitiatives/wave.php>

⁸ Network of Aquaculture Centres in Asia-Pacific (NACA): www.enaca.org

- A producer association is a legally constituted group of companies that provides a forum for cooperation and development of opinion.
- A producer organization is a cooperative that controls production and marketing by its members.

16. The level of organization, representativeness and effectiveness of producer associations varies throughout Europe, where there are strong national associations and regional federations as well as associations which are still growing in membership and influence.

17. Experiences of partnerships between science and the production sector were generally good, although awareness and communication of issues, problems and solutions can be further enhanced. This can be achieved through regular communication between partners, by formalizing consultations and participative coordination processes. Equally, efforts should be made to create conditions for the successful implementation of the outcomes of partnerships and stakeholder consultations. For the purposes of sectoral management, it can be important that consultation fora are institutionalized in order to facilitate partnerships and enhance involvement of stakeholders in information collection, knowledge building, policy development and decision-making.

18. Participants gave the following examples of partnerships between producer associations and science:

- provision of information to farmers;
- identification of producers' research needs;
- formulation of national and pan-European research agendas;
- environmental management and monitoring of shellfish production;
- market chain cooperation;
- restocking of lakes;
- identification of scientifically-sound criteria and parameters;
- provision of the quality of inputs used in aquaculture (e.g. feeds, seed, water, skills) and culture-based fisheries;
- training of producers;
- integrated management of lagoon fisheries and aquaculture;
- development of national aquaculture sector development strategies;
- identification of bottlenecks in policy and regulation and diversification of production;
- genetic strain improvement;
- organic carp production.

19. Examples of multi-stakeholder partnerships were: the management of lagoon fisheries in France and Italy which involve producers, scientists, processors, sellers and government authorities, a carp production consortium and a multifunctional carp farm in Hungary.

20. Aquaculture research increasingly addresses social and economic issues. These include financial management, product marketing, food safety, consumer preferences, integration with local area and regional management, and institutional, legal and governance aspects. Social science assessment methodologies are being increasingly applied. They examine interactions among stakeholders, analyze fishery product chains, identify development potentials in local and regional contexts and facilitate stakeholder participation, consensus building and policy formulation and implementation.

21. In some Eastern European countries and Turkey the willingness of aquaculture producers to adopt new information technology, such as e-mail and internet, is still fairly low; however, projects in some countries such as Russia are currently addressing this gap.

22. Many aquaculture scientists and individual producers are still production oriented and do not pay enough attention to the financial, marketing and quality aspects of the production processes. Market driven production is still not common in some Eastern European countries and Turkey, but efforts are under way to increase experience and to apply effective farm management for the production of competitive aquaculture products.
23. Partnerships to establish marketing chains for fishery products can enable producers to respond more effectively to consumer demands. Successful chains require cooperation among producers, their associations, scientists, wholesalers, the processing industry and retailers.
24. There may be a growing role for producer associations in providing regular technical, economic and financial advice to members, particularly on the economic and technical feasibility of “new” production systems developed by science or others in the industry. Partnerships between associations and science can assist aquaculture producers in: production (stocking density, feeding regimes), technologies (water efficient and environmentally friendly systems), management (to enhance skills in farm and business management), economics (e.g. cost-benefit analyses and economic feasibility studies) and marketing (such as related to low market prices, accessing market information).
25. New entrants in the aquaculture industry seem to have difficulties in obtaining unbiased and reliable information on production systems. There are still questions as to whether or not a producer association would be the most appropriate place to obtain the essential information for starting a new business in aquaculture and whether a producer association would be interested in assisting new entrants as more entrants would increase competition for the producer associations’ members.
26. The sometimes limited relationship between science on one hand and producer associations and individual aquaculture producers on the other, raises questions as to whether scientists charge too much for their services, for example water quality measurements, whether scientists do not market their services in the best way or do not respond adequately to the demands of the industry.
27. In addition to already established partnerships between science and aquaculture producer associations, broader and enhanced partnerships should be developed that include processing, marketing and retail businesses, NGOs, Governments and other key stakeholders.

SESSION 3: NEW SCIENTIFIC RESULTS FOR PRACTICAL APPLICATIONS

28. Consumer and food safety issues were recognized as a major priority for aquaculture producers and scientists. The food safety management model presented highlighted the need and opportunities for proactive and preventative management and communication approaches. Procedures such as Hazard Analysis and Critical Control Point (HACCP) should be introduced at farm level and producer associations may assist producers in their implementation. Consumer awareness of the quality and safety of aquaculture products should be enhanced. Scientists can assist producers in identification of hazards and management measures. Consumers should be made aware of such food safety management measures as are applied in aquaculture.
29. Production of sturgeon in Russia has increased significantly through aquaculture and culture-based fisheries techniques. This expansion is supported through R&D, stock assessment and monitoring efforts which also include the establishment of a living gene bank and domestic broodstock of eight species and various hybrids, as well as the development and extension of advice on optimal hatchery technologies. Research was conducted in collaboration with producers on the application of diludine in radio contaminated carp in Belarus. This research showed its possible use as an effective agent to remove the effects of radionuclides, as well as to

increase productivity, stimulate growth, prevent malformations and reduce mutagenic effects of environmental pollutants, thereby contributing to increase economic efficiency of the farmers' production.

30. Experiments on the effects of low stocking densities of grass carp on the pond ecosystem indicated that the use of grass carp might not always be helpful to reduce biomass of aquatic plants and that mechanical control of macrophytes may be preferred for pond management. Comparison of temperature data in carp ponds recorded over 45 years showed fluctuations which may have affected overall carp production. Basic research on a new sturgeon hybrid showed its potential for aquaculture but more research will be needed to confirm its viability and acceptability by consumers. Research on freshwater mullet in Tunisia indicated that the enrichment of mullet fry food with lecithin could be helpful during an acclimation period prior to their introduction in freshwater lakes in order to avoid the death of fry through loss of lipid reserves and to maintain membrane structures in freshwater. Researchers, in collaboration with the Polish Anglers Association, conducted long-term research on restocking of rheophilic cyprinids in Polish rivers, using pond aquaculture methods and artificial spawning technologies. As a result there has been an increase in number of pond farms producing fluvial cyprinids.

31. Participants discussed the differences between theoretical and applied research and the use of research outputs in practice. There is a need for research results and scientific terminology to be translated into language which can be easily understood by producers. Ideally, every aquaculture research paper should include a simple language summary of its main findings and practical applications.

SESSION 4: AQUACULTURE AND FISHERIES

32. The strong linkages between aquaculture and fisheries are illustrated by the fact that both sectors are involved in enhancement and rehabilitation schemes aimed at monitoring and improving fish stocks in inland waters.

33. The role of aquaculture is to produce food and generate income. However, some irresponsible aquaculture practices can harm the environment. Management practices have improved and environmental awareness in the sector has grown significantly. This has created the climate for responsible aquaculture. Furthermore, aquaculture is proving beneficial for the conservation and enhancement of endangered stocks (such as sea trout, salmon and anadromous whitefish). Aquaculture may also help increase public awareness of the importance of aquatic resources.

34. The decrease in aquaculture production in the Romanian Danube delta in the mid 1990's was attributed to the decrease in state subsidies, an increase in protected bird populations, reed invasion of ponds causing high costs for farmers and market liberalization which have led to a decrease in the demand for the cultivated Chinese carp.

35. The problem of market liberalization seems to be more of an Eastern European problem due to the fact that species produced are not always the ones demanded by the consumers. The changed market situation is forcing aquaculture producers to look into the possibilities of culture of non-traditional species. Science is assisting the aquaculture producers in this change through applied research.

36. Governments appear to have difficulties in involving aquaculture producers in planning and policy development if the producers are not organized in associations. The lack of producer associations in some Eastern European countries makes it hard for government and science to find partners that can contribute with new insights to discussions.

37. Aquaculture producers in some Eastern European countries are having difficulties with accessing credit and investment, as bad experiences of the past influence the willingness of banks to finance new investments in the sector.
38. The value of the catch by recreational anglers in the inland waters in Poland was estimated to be higher than of both commercial inland capture fisheries and aquaculture together; further research is needed to clarify this. Recreational fisheries is also important in terms of the number of people involved and its financial contribution to restocking activities in Western and Eastern European countries.
39. The UK, the United States, France, Poland, Ireland and Sweden all provide examples of partnerships and cooperation arrangements between anglers associations and governmental agencies. In some western European countries there is evidence of regular change in the species favoured by recreational anglers, for example, stocking of rainbow trout for fly fishers or carp for coarse anglers.
40. The construction of hydro-electric dams in major rivers in Turkey caused destruction of sturgeon habitat and led to a decrease in production. This, together with overfishing and insufficient enforcement of regulations is threatening sturgeon stocks with extinction.
41. Careful monitoring of environmental conditions and activities focused at maintaining genetic diversity should be promoted to assist governments in conservation of stocks, captive breeding and stocking programmes.
42. Attention was drawn to Aquainnovation⁹, an example of a partnership between science and producer associations and other stakeholders at pan-European level. This new partnership was set up in a project format, aiming to establish a network of stakeholders that should address the gaps in international transfer of technical information that is essential for SMEs.
43. The large variety of networks, producer associations and organizations described made it very clear that associations should adapt themselves to the local situation and the socio-economic situation of their members.

SESSION 5: RECOMMENDATIONS

44. The participants reiterated the importance of partnerships in the overall context of promotion of sustainable aquaculture development, in particular in the implementation of the provisions of the FAO Code of Conduct for Responsible Fisheries¹⁰ and the FEAP's Code of Conduct for European Aquaculture¹¹.
45. More focus is needed on the dissemination of technical information to aquaculture producers. Most scientific publications are not easily accessible to aquaculture producers and the main research findings require translation into accessible language in popular magazines. Another way of disseminating essential information is through workshops, meeting and conferences where private sector aquaculture producers can discuss and exchange experiences with scientists.
46. Strong professional associations are required to establish and maintain successful partnerships with the scientists. A multidisciplinary approach is required, whereby increasing attention is given to consumer, social and economic issues. Because of this, there is a trend

⁹ Aquainnovation: www.aquainnovation.net

¹⁰ FAO Code of Conduct for Responsible Fisheries: <http://www.fao.org/DOCREP/005/v9878e/v9878e00.htm>

¹¹ FEAP's Code of Conduct for European Aquaculture: <http://www.feap.info/FileLibrary/6/FEAP%20Code%20of%20Conduct.pdf>

towards broader cooperation and consultation involving multiple stakeholders, including potential investors. There is a need to access professional management and communication skills within the producer associations, a requirement that accompanies sectoral development and new market and consumer demands. Support is needed to develop and consolidate the producer associations in those countries where aquaculture is developing or changing.

47. Stronger national associations are needed to respond to legislative, market and consumer demands and to be able to respond to the requests for better self-regulation. Achieving this requires partnerships with science and efficient communication and networking. While such circumstances exist and are quite strong at the European level, efforts are needed to improve dissemination and cooperation at the most basic levels.

48. The symposium recommended that:

- Durable partnerships be promoted at the local, national and international levels, highlighting the requirement for skill development and securing financial resources for the operation of producer associations.
- Awareness of the European Union RTD programmes applicable to SMEs and associative grouping be promoted and their potential application for partnership creation/consolidation be implemented.
- International and intergovernmental organizations, such as EIFAC, FEAP and EAS continue work together to demonstrate the benefits and contributions of partnerships in the promotion of sustainable freshwater aquaculture.
- Core funding be sought to promote networking and to overcome language barriers that limit effective dissemination of results and communication among inland fisheries and aquaculture stakeholders.
- Organizations such as EIFAC address the social and economic influences on the sustainability of inland fisheries and aquaculture.

49. Scientists and aquaculture producers associations should jointly take into account the consequences that research can have for their future activities, as some research outcomes might negatively affect development of the sector.

50. The importance of partnerships among producer associations at national level was highlighted and the current restructuring of national federations of associations in France and Denmark were given as examples.

51. Participation should be sought from stakeholders that represent nature conservation as many partnerships lack a partner representing conservation or environmental approaches.

52. Participants congratulated EIFAC and the organisers of this symposium for selecting the topic of “aquaculture development-partnership between science and producer associations”. It was concluded that partnerships between science and producer organisations are important not only for the further development of the aquaculture industry but also for the development of inland fisheries. It was recommended that EIFAC continue this approach at future symposia, and even widen the scope of the symposia by including other relevant stakeholders.

53. It was also recommended that EIFAC consider new ways to stimulate active interaction between the diverse interests represented at the symposium, while keeping focussed on the meeting’s objectives and themes. Future meetings could include parallel sessions and specific workshops, to increase time-effectiveness and the quality of the final recommendations. Such an approach will stimulate contributors to the meeting to better focus on the respective topics.

54. One of the main challenges for partnerships between science and producer associations is to establish and maintain effective communication. Funding constraints for applied research

are common, as some consider that the sector should contribute to its own applied research programmes and activities. Nevertheless, government funding for aquaculture research is still needed.

55. Some large aquaculture feed producing companies in Europe have established very effective dissemination systems for their applied research and provide information and advice to aquaculture producers on many more issues than feeding regimes.

56. The use of simple, non-specialist language for the dissemination of aquaculture information from science to aquaculture producers is essential and adds value to newsletters and internet based tools such as, for example, AquaFlow and Aquamedia.

57. Participants drew attention to the lessons that can be learned from outside the European region. In particular the advances in Asia in co-management and the value of Asian approaches can be valuable for Europe. Because of this interregional exchange of information is also required.

58. It was also concluded that:

- there are strong linkages between aquaculture and fisheries;
- both are strongly involved in rehabilitation schemes aimed at improving fish stocks in inland waters;
- the changing market situation forces aquaculture producers to look into the possibilities for the culture of other species;
- the large variety of networks and producer associations shows that the local social and economic situation of its members are basic determining factors for the activities of the association; and
- recreational fisheries are important for the development of aquaculture, the rehabilitation of fish stocks and for the economy.

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ON
AQUACULTURE DEVELOPMENT – PARTNERSHIP BETWEEN
SCIENCE AND PRODUCER ASSOCIATIONS**

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INTRODUCTION: PARTNERSHIP BETWEEN SCIENCE AND PRACTICE AS A KEY ELEMENT OF AQUACULTURE DEVELOPMENT

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The necessity for close collaboration between science and practice has been recognized for a long time in many areas of food production, including aquaculture. The successful developments in the aquaculture industry can be attributed to the application of research results by the commercial sector. It is true that the success of an industry depends on many factors such as resources, production technology, management, the market, financing, and its public image. However, modern aquaculture is a knowledge-intensive industry, which needs appropriate research and development work in collaboration with science and practice.

There are, however, some specificities in aquaculture that make the transfer of new knowledge and the application of new scientific results in farming conditions difficult. One such specificity is the dominance of micro-, small- and medium-sized enterprises in the aquaculture industry. This is a typical phenomenon not only in Europe but also in many other regions, including Asia – the main aquaculture producing region of the world. Small farms, which are usually dispersed over a relatively large geographic area, have significant constraints in keeping close contact with scientific institutions and accessing new knowledge and results in their specific fields of interest. The lack of resources needed to modify their farming practice and change their technology is also a major obstacle in putting new scientific results into practice. Language difficulties should also be recognized when access to new research results is considered on a regional level. However, one of the major problems may be the attitude of a large number of farmers and their lack of readiness for innovation. Many farmers believe that they know what to do and that research may not help them very much, being too theoretical. In addition, they often say that they are too busy with everyday work and that the major constraint in the development of their farming system is the lack of money for innovation and investment.

While valuable scientific knowledge and excellent results have been generated in a large number of aquaculture research institutions all over the world in recent decades, a significant part of the results have not been applied in practice. Scientific institutions often follow a science-led approach, where the main objective of their research is the generation of new knowledge and a better understanding of various natural processes. Scientists often say that their performance is evaluated mainly according to their publications in peer-reviewed professional journals; the transfer of new knowledge to the industry is not regarded by these scientists as one of their tasks. Researchers sometimes fail to have sufficient knowledge about the actual problems of the industry and, in many cases, new R&D projects do not respond to the real needs of the commercial sector.

In spite of these difficulties, both the scientific and production sectors in aquaculture have recognized the need for responding to new challenges, such as (market) globalization, and environmental, ethical and food safety issues, and have taken various steps in order to improve their sustainability and competitiveness. There has been significant progress in the establishment of various producers associations, especially in Europe where the Federation of European Aquaculture Producers (FEAP) became an important stakeholder in developing realistic and effective policies, regulations and projects for aquaculture development. FEAP

has also been involved in the implementation of such policies and projects. There have also been substantial changes in the aquaculture sector in Eastern Europe in the past ten years of the transition of market economy, which have resulted in the establishment and strengthening of numerous producers associations. The European producer associations are in consultative or cooperative relationships with governments. Although the degree to which this is so varies according to the socio-economic conditions in each country. There is also an inter-regional dimension of partnership between science and producers. Despite specific regional differences there are significant similarities in problems and perspectives, for example between Asia and Europe. The partnership between European organizations and the Network of Aquaculture Centres in Asia Pacific (NACA) can foster an enhanced involvement of farmers and aquatic resource users in the development of R&D and policy in both regions.

There have also been structural and functional changes in the European aquaculture research sector in the past two decades, in response to the changes in EU research policy, which now focuses on broader issues such as food safety and environmental protection. The EU research policy on fisheries and aquaculture is based on the principle that “European aquaculture is a self-sustainable industry, which is expected to cater for its own R&D needs”. The European aquaculture industry is highly diverse, however, ranging from part-time artisanal activities to large operations conducted by publicly quoted international companies; therefore their capacity to pay for their own research varies greatly. Thus there is still a need for public research and public-private partnership in order to carry out research projects using EU and government funds, especially in the New Member States of the EU. The Collective and Cooperative Research Programmes of the EU (e.g. CRAFT) offer good opportunities for partnership between SMEs and research institutions to carry out applied research.

In Eastern Europe various types of assistance, including advice and capacity-building in the scientific, technical, financial and economic aspects of aquaculture are required. A positive development has been the recent establishment of the Network of Aquaculture Centres in Eastern Europe (NACEE), which in 2005 includes 30 research institutes, universities and aquaculture organizations in 13 Eastern European countries. The main objective of NACEE is the integration of Eastern European aquaculture institutions into the European Research Area, which also contributes to the development of partnerships between science and industry.

The strategy of the European Community for the Sustainable Development of European Aquaculture also emphasizes the importance of collaboration by all stakeholders of the sector and partnership between science and producers. The Strategy clearly states that stakeholder participation must be further developed, which means that the respective roles of governments and the private sector must be redefined, and that stakeholder (producers associations, researchers, consumers, and special interest groups) participation and consultation in policy planning must be further developed. The Financial Instrument for Fisheries Guidance (FIFG) also allows the financing of applied research initiatives. Producers and scientists may better utilize the instruments available at the Community level for their mutual benefit, and for the development of the sector.

Various European organizations, such as Aqua-TT, the European Aquaculture Society (EAS), the European Inland Fisheries Advisory Commission (EIFAC) and EUROFISH also contribute to the enhancement of collaboration between science and practice through their specific actions and projects. There are growing numbers of projects in which European organizations, together with FEAP, major scientific institutions and innovative farms (of various sizes) carry out projects that address specific needs of the industry. These include Aquaflo (disseminating RTD information); PROFET (identifying research needs); WAVE (improving competence levels); and CSN INTRAN (supporting innovation and technology transfer).

The EIFAC Symposium on “Aquaculture Development – Partnership between Science and Producers Associations”, organized from 26 to 29 May 2004 in conjunction with the Twenty-third Session of EIFAC in Wierzba, Poland, was a unique opportunity for professionals, both from science and practice as well as for other stakeholders in European aquaculture to meet, exchange ideas and take steps towards improved partnership. Out of 37 experience papers, 14 have been selected for publication in these proceedings. The topics of these selected papers were the most relevant to the main theme of the symposium. These papers well illustrate the efforts of both scientists and producers towards enhancing their partnership, as well as the results of their collaboration. The work of these partnerships has contributed to improvements in the quality and safety of fish and seafood products, to the responsible use of aquatic resources, and to the better livelihood of rural communities.

“AKVAPARK” ASSOCIATION: A TOOL FOR ENHANCING PARTNERSHIP BETWEEN SCIENTISTS AND FARMERS IN HUNGARIAN AQUACULTURE

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ABSTRACT

The political and economic changes in Hungary offered a good environment for restructuring the old-type organizational and functional system of the Fish Culture Research Institute (HAKI) in Szarvas, Hungary; however, the serious cutback in research funding also necessitated the restructuring of the institute. During the rather painful restructuring process, the staff was reduced from 250 to 62 but the consequences were alleviated by creating “satellite” companies that took over the more directly business-oriented tasks of the institute. These companies also absorbed a large part of the redundant personnel. HAKI, and the eleven newly-formed small private enterprises decided to form the “AKVAPARK” Association in 1996. The main objective of the AKVAPARK Association is to coordinate the operation and development of the unique complex of available aquaculture-related facilities, to make joint efforts to implement joint R&D, extension and training programmes, and to maintain traditional professional and human relationships among its members. The paper discusses the results and experiences of the operation of the Association between 1996 and 2004.

Key words: *Hungary, AKVAPARK Association, aquaculture, HAKI, partnership*

Introduction

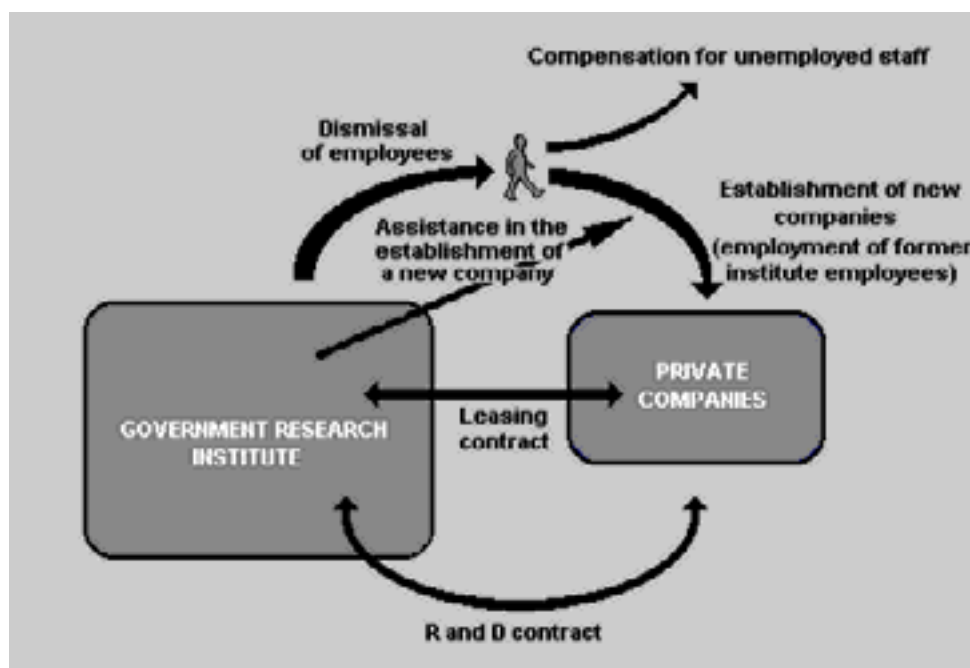
There have been fundamental structural changes in the R&D sector in Eastern Europe in the early 1990s as a result of the social and economic changes in the region. These changes were not always systematically planned or properly controlled; rather they were the results of various attempts by the R&D institutions to survive under the sudden and serious financial constraints that they faced. In the turbulent political and economic environment of change, research and development aspects seldom got priority during the implementation of reform programmes. No effective measures were taken to protect the tremendous value that had been accumulated in R&D institutions, when restructuring the rather large and rigid institutional system. Their large size, in terms of facilities and land area, and their considerable number of employees, were typical features of agricultural research institutes in Hungary. These public research institutes received substantial government funding every year, which was drastically cut back within one year when economic reforms took place in the early 1990s. Faced with this situation, R&D institutions responded by reducing staff levels, closing down facilities, and cutting back research activities. Since the state was the only important customer of research institutions in the past, most of these institutes did not recognize the benefits of partnership with newly established, usually small, private enterprises. At the same time, R&D was not a priority of the new private farms, which were very much more occupied with stabilizing their new business activities. However, there have been examples of attempts to develop partnership between research institutes and private farms, in order to join forces to cope with the new challenges in aquaculture development.

Establishment of the Akvapark Association

Restructuring of the Fish Culture Research Institute (HAKI)

The Fish Culture Research Institute (HAKI) in Hungary was one of the research institutes of the Ministry of Agriculture and Food at the time in the early 1990s when the political and economic changes took place in Hungary. Beside research laboratories and other experimental facilities, the institute operated an experimental farm with a total area of 800 ha and employed 250 people. The experimental farm included fish ponds, arable lands, a duck farm, a fish feed mill and a large service unit having workshop, transport and construction facilities. Realizing the unsustainable nature of the structure and function of the institute, its management developed and approved a restructuring programme, which was based on the separation of research from profit-oriented activities, as shown in Figure 1. The staff complement was reduced from 250 to 62 during the implementation of this programme; however, 25 others were able to continue their original work in one of the newly established private companies.

FIGURE 1
Scheme of the HAKI restructuring programme



All the employees received compensation, which was paid by the Ministry of Agriculture and Food. The sum they received helped them to establish their own small private enterprises. The institute also assisted the commencement and strengthening of these new enterprises by offering reasonable rental fees for the use of institute facilities, which then were operated by the newly formed small and medium sized enterprises (SMEs). These new companies were also allowed to pay for feed, fish and other materials in installments. Eight SMEs were formed during the restructuring programme, including three fish farms, a duck farm, a fish feed company, a construction company, a water chemistry laboratory and a vegetable oil processing plant. The institute also signed R&D contracts with some of the companies and involved them in certain projects, which were funded either by the government or external donors.

After the completion of the restructuring programme, the institute only operated the special research facilities, which represented 21 percent of its total asset value. Some facilities were also sold during the restructuring programme; however the value of these was less than ten percent of the total asset value. The restructuring programme, which took place from 1991 to 1995, was a very difficult process with a lot of personal conflicts. However, the results proved the appropriateness of the decisions of the management, when one looks back from the perspective of more than ten years.

Establishment of the AKVAPARK Association

The potential benefits of collaboration among the new SMEs and HAKI, as the “mother institute” have been well recognized by the managers of the new companies. However, the reluctance to share business information, the instinctive effort to veil difficulties, and some personal conflicts worked against closer collaboration among the new companies. As a result of the consolidation of the new enterprises in their business activities and an acceptance of the new situation, the companies eventually overcame their previous aversion towards collaboration. However, the role of HAKI as a moderator and coordinator was essential, in order to take resolute steps towards the establishment of a legally registered association.

Finally, the AKVAPARK association was established on 29 March 1996. The word “Akva” (Aqua in English) in the name of the association refers to the basic resource that plays an important role in the activity of all member companies. The association is a non-profit organization, in which all members are independent; however, they regularly exchange information and explore possibilities for joint business activities and R&D projects. The annual membership fee is 20 000 HUF (about €80) for companies and a token 1 000 HUF (€4) for individuals. The association has no full time employees; administrative work is carried out by a part-time secretary. The President of the Association is the Director of HAKI, the two Deputy Presidents and the Secretary of the Association are managers of member companies. The main objectives of the AKVAPARK association are to:

- coordinate the operation and development of the unique complex of aquaculture-related facilities developed in HAKI during the past forty years;
- implement joint R&D, extension and training programmes; and
- maintain traditional professional and human relationships among members.

Between 1996 and 2004 two member companies have been liquidated, however, the assets have been bought by other AKVAPARK members and their activities have continued. Three SMEs and four individuals joined the association during this period. The list of current members is shown in Table 1.

Results and Experiences of the AKVAPARK Association

The Association organizes regular meetings at least twice a year, but there are several ad hoc meetings and consultations, according to actual requirements. HAKI plays a mediating and coordinating role in the Association, but also provides various services for members and assists the preparation of joint R&D projects. The operation of the Association contributed directly and indirectly to the strengthening of business activities of member companies. As a result of the joint efforts of HAKI and the Szarvasi Haltáp feed manufacturing company, which rents some facilities of HAKI, the fish feed mill has been upgraded and a new extruder line was put into operation.

TABLE 1
Members of AKVAPARK Association (May 2004)

No.	Name of member	Type of company	Activity	Annual turnover and number of employees
1	Research Institute for Fisheries, Aquaculture and Irrigation, HAKI	Public institute	Research and development	€2.1 million 100 employees
2	Szarvasi Haltáp Ltd	SME	Fish feed manufacturing	€1.3 million 11 employees
3	Szarvas-Fish Ltd	SME	Intensive fish production, fish processing and marketing	€1.0 million 12 employees
4	INNOFLEX Ltd	SME	Fish production in ponds, intensive systems, fish processing and marketing, consulting engineering, manufacturing of hatchery and fish farm equipment	€700 000 14 employees
5	Szarvasi Kacsafarm Ltd	SME	Duck breeding and rearing (production of "natural duck")	€200 000 9 employees
6	Agro-Aqua Ltd	SME	Pond fish production	€52 000 2 employees
7	Arboretum Hunting Club	Association	Wildlife management	€56 000 4 employees
8	Aqua-Copy Dep. Co.	SME	Laboratory services	€50 000 5 employees
9	Double Delta Dep. Co.	SME	R&D services	€18 000 3 employees
10	Növényolaj Dep. Co.	SME	Vegetable oil processing	Not operating at the moment
11	Shubunkin Ltd	SME	Fish production and marketing, consultancy in aquaculture	€48 000 3 employees
12	Szentes és Táros Ltd	SME	Breeding and production of pike-perch	€4 000 No registered employees
13	Víz és Hal Dep. Co.	SME	Consultancy in aquaculture and water management	€12 000 1 employee
14-18	5 private members	Individual		

The internationally acknowledged R&D environment also contributes to the development of international business activities by member companies. For example, the INNOFLEX and Szarvasi Kacsafarm companies supplied fish hatcheries, ducklings and fish and duck rearing facilities to North Korea in a frame of business contracts signed with local enterprises. There are other contracts in preparation with various Eastern European and non-European countries.

The operation of the Association resulted in the participation of AKVAPARK members in numerous national and international projects since 1996. Some major national projects, which have been carried out jointly (two or three AKVAPARK companies, together with HAKI) between 1998 and 2003, are listed below:

- effect of processing technology on the consumption quality of feeds in fish culture;
- development of a combined intensive/extensive pond recirculation system;
- development of environmentally friendly duck production on fish ponds;
- development of fishpond/wetland systems for treating fish farm effluents; and
- development of floating fish feed production technologies by extrusion.

Two members of AKVAPARK, namely HAKI and Shubunkin Ltd, are members of an international consortium, which is carrying out an EU funded CRAFT project on the Bio-Economic Feasibility of Intensive Culture of Pike-Perch. The AKVAPARK Association has also entered the international arena of aquaculture R&D work, as a participant in EU funded projects. AKVAPARK was involved in the implementation of the AQUAFEED and AQUAFLOW Projects and the Association is one of the participants of the project called INTRAN CSN, which aims at the development of an innovation network in aquaculture.

In the framework of a PHARE project, a new innovation centre (“Innovation Centre for Agricultural Water Management”) has been built within the campus of HAKI. The project idea was developed from the experiences of AKVAPARK, and the new centre became its headquarters, where well-equipped offices, meeting rooms with up-to-date facilities and broad-band internet connection are available for the companies accommodated in the building.

Based on results and experiences of AKVAPARK, which were gained between 1996 and 2005, a SWOT analysis has been prepared, together with an action plan. The results of the SWOT analysis and the resultant action plan are summarized below:

Strengths

- common past of the companies and traditional personal ties;
- close relationship with a research institute;
- availability of facilities; and
- ability to carry out complex R&D projects.

Weaknesses

- excessive involvement of companies in day-to-day activities;
- weak commitment to R&D activities, due to unfavourable experiences with past projects;
- persistent reluctance to collaborate with other companies and R&D institutions; and
- limited resources for improving management.

Opportunities

- access to new projects in the European Union;
- increasing importance of innovation projects; and
- international business opportunities in Europe and worldwide.

Threats

- limited national funds for “innovation projects”;
- companies losing interest in collaboration, either because they are getting richer or getting poorer; and
- weakening of HAKI as a cohesive force due to under funding.

Action plan

- efficient use of the new “Innovation Centre for Agricultural Water Management”;
- more active collaboration with the Hungarian Innovation Society;
- strengthening of the management of the association;
- active exploration of new projects and business opportunities, based on the strengths of the association as identified above; and
- development of international cooperation with similar organizations in the EU and in non-EU Eastern Europe.

Conclusions

The AKVAPARK Association was a pioneering initiative in 1996 that aimed at the development of partnership between science and production, the more efficient use of R&D resources, and the enhancement of the innovation potentials of SMEs involved in aquaculture. The evolution of aquaculture development proved the appropriateness of the original idea, since there is an increasing need for collaboration among stakeholders of the aquaculture sub sector and there has been an improvement in the innovation capacities of the aquaculture enterprises involved in AKVAPARK. Both the research member of the Association (HAKI) and the SMEs have benefited from its operation. Innovation support became an important element in the activities of HAKI, which enables the institute to participate successfully in various innovation programmes, together with suitable aquaculture enterprises. The member SMEs of the Association have remained in close contact with partner SMEs and with the “mother institute” HAKI, which resulted in the development of their facilities and technologies, the improvement of their management skills, and consequently an increase in their profitability and competitiveness.

AQUACULTURE DEVELOPMENT AND ITS PARTNERSHIP BETWEEN SCIENCE AND PRODUCERS ASSOCIATIONS IN TURKEY

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ABSTRACT

Turkey, with 8 333 km of coastline, many rivers with a total length of 177 714 km, nearly 900 000 ha of natural lakes and more than 300 000 ha of dam lakes, has great potential for fisheries and aquaculture. With a total fisheries production of 664 492 tonnes in 2004, Turkey is one of the most important fisheries countries in the region.

The most important inland species are grey mullet, common carp, crayfish, pike-perch and snails. Though the contribution of the inland catch to total fishery production is relatively small (7%), its contribution to the rural areas in terms of fish supply and employment is significant.

Aquaculture production has expanded rapidly, from around 3 075 tonnes in 1986 to 94 010 tonnes in 2004. The contribution of aquaculture to the total fish supply has also rapidly increased from 0.5 percent in 1986 to 14 percent in 2004. Inland aquaculture has been undertaken in Turkey for a number of years, with the majority of production coming from carp and trout.

There are a number of universities, institutes and NGOs related to fisheries and aquaculture that have been participating in the decision-making process in Turkey. In the past decade there have been increasing efforts to address opportunities and needs for more sustainable aquaculture development.

Parties and governments should be urged to adopt best management practices and legal and institutional arrangements for sustainable aquaculture, in particular through implementing Article 9 of the FAO Code of Conduct on Responsible Fisheries. Governments, scientists, producers associations and other stakeholders should create partnerships and collaborate to ensure that aquaculture development is environmentally sustainable.

Key words: *Turkey, aquaculture, environmental sustainability, partnership, producers association, science, stakeholder*

Introduction

General view

Aquatic living resources provide an important and increasing source of protein in many countries. Aquaculture has been the world's fastest growing food production system (Muir, 1995). Global aquaculture production is growing at more than ten percent per year, compared with three percent for terrestrial livestock and 1.5 percent for capture fisheries.

Total fish production in Turkey reached 664 492 tonnes in 2004. As shown in Table 1, most of the production arises from capture fisheries. In 2004, catches were 550 482 tonnes, strongly dominated by marine catches that contributed about 92 percent of the total wild fish supply and 78 percent of total national fish output.

TABLE 1
Total fisheries production in Turkey in 2004

Type	Volume (tonnes)
Marine capture fisheries	504 897
Freshwater capture fisheries	45 585
Total capture fisheries	550 482
Freshwater aquaculture	44 115
Marine aquaculture	49 895
Total aquaculture	94 010
Total production	644 492

Source: Ministry of Agriculture and Rural Affairs

Aquaculture in Turkey is in full expansion mode, in comparison with the capture fisheries, which are not showing real growth. In 2004, one fish out of ten came from fish farming in Turkey; concerning freshwater fish, more than two fish out of three stemmed from aquaculture. Fish farming production rose from 4 100 tonnes in 1988 to 94 010 tonnes in 2004, an average annual growth rate estimated at 14 percent.

Topography

Turkey is located at a point where the three continents making up the Old World – Asia, Africa and Europe – are closest to each other. The land borders of Turkey total 2 573 km, and the coastlines stretch another 8 333 km. Turkey is surrounded by sea on three sides, by the Black Sea in the north, the Mediterranean in the south and the Aegean Sea in the west. In the northwest there is also an important internal sea, the Sea of Marmara, between the straits of the Dardanelles and the Bosphorus, important waterways that connect the Black Sea with the rest of the world.

Most of the 33 rivers flow into the seas surrounding the country. The longest rivers, the Kizilirmak, Yesilirmak and Sakarya, flow into the Black Sea. Turkey has up to 200 natural lakes reaching a total surface area over 900 000 ha. The largest in Turkey is Lake Van. Central Anatolia has the second largest lake, Tuz Lake. As a result of the construction of dams during the past thirty years, several large dam lakes have come into existence. In 2004, 159 dams were recorded by the Ministry of Agriculture and Rural Affairs (MARA), representing a surface area of around 343 000 ha. The other inland fish producing sources are 750 ponds totaling over 15 000 ha (Table 2).

TABLE 2
Aquatic Resources of Turkey

Marine		Length (km)	Surface area (ha)
Black Sea, Aegean Sea and Mediterranean Sea of Marmara, Bosphorus and Dardanelles		7144 1189	23 475 000 1 132 200
Total marine resources		8333	24 607 200
Freshwater	Number	Length (km)	Surface area (ha)
Natural Lakes	200	–	906 118
Dam Lakes	159	–	342 377
Ponds	750	–	15 500
Rivers	33	177 714	–

Source: Ministry of Agriculture and Rural Affairs

Fisheries Production

Marine fisheries

Despite marine capture fisheries historically contributing over 90 percent of the total catch, this decreased in the late 1980s, and in 2004 accounted for 504 897 tonnes, representing 78 percent of total fish supplies. Marine fish production increased until 1988 when it reached a peak of 623 404 tonnes, but then declined sharply to 317 425 tonnes in 1991. The sharp decrease between 1988 and 1991 has mainly been attributed to a fall in the catch of anchovy, which is related to a combination of over-fishing and the accidental introduction of a jellyfish (*Mnemiopsis leidyi*).

Anchovy remains the most important species in the marine fisheries of Turkey, accounting for 50 percent of the total catch (295 000 t). Grey mullet, hake, whiting and sardine are also significant.

Freshwater fisheries

Despite Turkey having vast resources for freshwater fisheries, these accounted for only seven percent of the total fish supply in 2004 (Table 1). The most important species are grey mullet, common carp, and – to a lesser extent – crayfish, pike-perch and snails. Common carp is distributed throughout the country but grey mullet is found only in Lake Van. Stocking activities have been carried out to enhance freshwater resources by MARA, the Ministry of Environment and Forestry and the General Directorate of State Hydraulic Works, Ministry of Energy and Natural Resources. The main species used for stocking are common carp and mirror carp; to a lesser extent grass carp, trout, wels and perch are also stocked.

Southeast Anatolian Project (SAP)

Freshwater resources, in connection with irrigation and energy production purposes, are increasing steadily; the south-eastern region is an important area in this regard. A number of big dams on the Euphrates, Tigris and other rivers of the region have been constructed within the framework this special regional project, which will provide 220 000 ha of water surface. Total freshwater fish production will increase by 10 000 tonnes with the completion of the

project. The dam lakes in this area and other water resources create possibilities for many different fish species to be grown.

Aquaculture Production

Until recently, the aquaculture industry in Turkey was almost entirely confined to the production of rainbow trout in freshwater. Commercial-scale utilization began only in the late 1980s, and has grown rapidly into an important activity that is considered by industry and government to have further potential for increasing both regular domestic fish supply and export earnings. The production reached 94 010 tonnes in 2004, having been only 3 075 tonnes in 1986, a more than 30 fold increase in the last two decades (Table 3).

TABLE 3
Aquaculture production in Turkey by species, 1998-2004 (tonnes)

Species	Years						
	1998	1999	2000	2001	2002	2003	2004
Common carp	950	900	813	687	590	543	683
Rainbow trout	32 340	36 870	42 572	36 827	33 707	39 674	43 432
Sea trout	2290	1700	1961	1 240	846	1194	1650
Atlantic salmon	40	0	0	0	0	0	0
Seabass	8660	12 000	17 877	15 546	14 339	20 982	26 297
Seabream	10 150	11 000	15 460	12 939	11 681	16 735	20 435
Mussels	2 000	500	321	5	2	815	1513
Shrimp	270	30	27	0	0	0	0
Total	56 700	63 000	79 031	67 244	61 165	79 943	94 010

Source: Ministry of Agriculture and Rural Affairs

The contribution of aquaculture to the total fish supply has also rapidly increased from 0.5 percent in 1986 to nearly 14 percent in 2004. As with increases in total aquaculture production, the number of licensed fish farms has also steadily increased in the last decade, reaching 1 564 in 2004, of which most are small with a production of <50 tonnes/year.

Marine aquaculture production has expanded faster than freshwater aquaculture. Most marine fish farms are located in the southern Aegean coastline and produced 45 000 tonnes (nearly 50 percent of the total aquaculture production) in 2004. There are 33 seabass and bream farms using earthen ponds, with an average capacity of 20 tonnes/year. Trout are also produced in the marine environment (1 650 tonnes in 2004) in the Black Sea at both portion and large size. Black sea turbot have been successfully produced at an experimental level in this location. The culture of other species has also been practiced in recent years to diversify aquaculture production; the species cultured include red seabream, thick-lip mullet, stripped grey mullet, white grouper and dentex.

Since the first marine hatchery was established in 1986, the number of hatcheries had reached 18, with a total production of ~200 million fry/year in 2004. Most rely on resources purchased from government hatcheries and/or private hatcheries in the country, or the import of certified disease-free fertilized eggs from overseas.

At first, most Turkish farms were small but there has been an increasing trend to establish larger marine farms and to enlarge existing ones. In this regard, 29 offshore farms have been established with a production of 32 991 tonnes in 2004. This trend is due not only to the advantages of economies of scale but also to conflicts of interest in coastal zone use.

In 2001, the first bluefin tuna (*Thunnus thynnus*) farm was established in the Mediterranean with a production capacity of 840 tonnes/year; by 2004 there were six bluefin tuna farms in operation, with a total production of 6 300 tonnes.

Trout is the most cultured fish in Turkey, representing 48 percent of the total aquaculture production in 2004. Trout farms are widely dispersed across the country; there are 1 141 in the 74 provinces where fish farms exist. Trout culture in cages has become an attractive and expanding activity in recent years. Carp culture has declined since 1989, due to poor demand and market value; its share in the total aquaculture production has dropped dramatically from 66 percent in 1986 to 0.7 percent in 2004. Some reservoirs have been opened to aquaculture activity since 1994, an important stage in utilizing freshwater bodies. In order to limit the environmental impact of aquaculture activities only one percent of the surface (circa 300 000 ha) of the selected reservoirs is allocated for this purpose.

Aquaculture Policy, Administration and Legislation

MARA is the main state organization responsible for aquaculture administration, regulation, protection, promotion and technical assistance. All fisheries activities are based on the Fisheries Law No. 1380, which gives aquaculture investors the right to rent marine or land areas for this purpose (Deniz, 2002). There is a coastal zone management plan related to aquaculture under preparation.

The Turkish Constitution states that central administration practices are followed; yet local authorities hold the office as points of administration. Authority over aquaculture is divided between MARA, the Ministry of Transportation, the Ministry of Health, the Ministry of Environment and Forestry, the Department of Water Works, and the Ministry of Finance, but involvement by the Ministry of Tourism and Culture and the Ministry of Internal Affairs are also experienced.

The Fisheries Law of MARA governs access to public land by aquaculture investors and the Treasury, which owns the public lands and water resources and regulates leasing. Law No. 1380 controls the issue of licenses to practice aquaculture in public areas. MARA issues licenses for freshwater usage, after approval from the Department of Water Works of the Ministry of Energy and Natural Resources, the Ministry of Environment and Forestry, or local authorities.

To ensure sustainable development, the licensing, establishment and control of fish farms have been ruled by ministerial decree. To maintain an environmentally sound development an EIA needs to be provided for individual sites where fish farmers apply for a license. Legislation and directives are based on the fisheries law but many problems exist, due to the presence of a vacuum; both legal provisions and tendencies create overlaps between aquaculture, tourism, environment, commerce and industry, water works, forestry and culture.

The Fisheries Law is very old and is unsuitable for the aquaculture sector. For this reason, and in order to establish a more effective licensing and control mechanism, new aquaculture

legislation is under preparation, in line with a draft report prepared by international consultants. An additional problem is that there are eight institutes involved in the decision-making process regarding licensing for farms and the granting of leases for specific sites to be used for aquaculture. Furthermore, many ministries have responsibilities for the same topics, such as water quality, pollution and food safety; this makes it very difficult to reach agreement.

Thus the privileges and responsibilities of aquaculture producers are neither specific nor well-defined and protected.

Education and Research

Education

Until 1982 fisheries education had been part of other related sciences, such as biology and animal husbandry. By 2004, there were 15 universities in Turkey that have faculties of fisheries, fisheries departments, or fisheries institutes. Ten universities had fisheries departments offering two-year training courses for technicians. In addition, two fisheries vocational schools were providing training for master fishermen, fish processors and more technical aspects of the fisheries industry. About 3 500 students were undergoing fisheries and aquaculture education and 4 500 students graduated from these universities.

Research institutes

To ensure sustainable development in the fisheries and aquaculture sector, special attention has been given to research activities by MARA. At present (2004) there are four research institutes of the Ministry dealing with fisheries and aquaculture research. Two that are in charge of marine fisheries are located in the Black Sea and the Aegean regions. Another two are in charge of inland fisheries and are located in the central and eastern Anatolian regions.

Research activities in marine fisheries are undertaken by two Fisheries Research Institutes, one in the Black Sea (Trabzon) dealing with fisheries and associated environmental issues, and the other in the Aegean/Mediterranean region (Mugla) concentrating on the fisheries problems there. A third Institute is established in the Central Anatolian Lakes district (Isparta) and is engaged in freshwater fisheries research activities. A fourth one is established in the eastern Anatolian region (Elazig) and is also engaged in freshwater fisheries research activities. These institutes maintain close links with international organizations to follow progress in research and to exchange information and data on current research initiatives. They also have close links with the Turkish Scientific and Technological Research Council, in order to benefit from its large data processing facilities.

In addition, several universities also carry out research on fisheries and aquaculture.

Fisheries Cooperatives and Producers Organizations

Fisheries cooperatives

There were 450 fisheries cooperatives with a membership of nearly 24 000 in 2004. About 40 percent of these are concerned with freshwater fish, and may be involved in production, storage and processing, as well as marketing. Through cooperation, members can gain the advantages of marketing economies of scale; economies in transport; and cheaper bulk purchases of packaging materials, for example; they also enhance their bargaining power in negotiating selling prices. Cooperatives are promoted through the General Directorate of Organization and Support of the Ministry of Agriculture and Rural Affairs (Table 4).

TABLE 4
**Numbers of cooperatives and their members by regions
 in Turkey in 2004**

Region	Number of Cooperatives	Number of Members
Black Sea	84	4 807
Marmara	122	7 008
Aegean	80	4 856
Mediterranean	65	3 435
Central Anatolia	39	1 983
East Anatolia	44	1 566
South-East Anatolia	16	345
Total	450	24 000

Source: Ministry of Agriculture and Rural Affairs

The quantity of fish sold via cooperatives is generally small – not more than seven percent of production in the past ten years. Selling directly to a cooperative may not realize as good a return as could be obtained by selling directly to wholesalers. Cooperatives in the Aegean region charge fishermen 15 percent of the selling price; ten percent of this goes in taxes and fees and five percent is retained by the cooperative. They are more important in the marketing of freshwater fish and fish caught in lagoons, where exclusive fishing rights may be granted to the cooperative.

There are two cooperatives associated with aquaculture in Turkey in 2004. Cooperatives have certain advantages in leasing water resources and to obtain incentives and credit.

Producers organizations

Recognizing the importance of non-governmental organizations in decision making, and in order to adapt production activities to the needs of the market, two foundations and four associations have been established with the encouragement of the government. In 2002, to promote and increase the consumption of fish in the country, the “Fish Promotion Association” was established, with the participation of the government, NGOs and private companies.

Conclusions

There are a number of universities, institutes and NGOs related to fisheries and aquaculture and they have been participating in the decision-making process in Turkey. Most of the problems involve the lack of coordination and collaboration between government, science and producers organizations.

Since 2000 there have been increasing efforts, at national and international levels, to address opportunities and needs for more sustainable aquaculture development. Sustainable issues associated with aquaculture development have attracted the attention of government

authorities, the private sector, environmental NGOs, the academic community, international agencies, the media and the general public.

There is no single planning and management framework that can be applied universally to promote more sustainable aquaculture development. Policy makers and planners must therefore critically appraise the options open to them, and make their own choices depending on local circumstances.

In order to make the NGOs efficient to manage the agricultural sector, including fisheries and aquaculture, a law has been approved by Parliament that will force farmers to establish producers unions. Integration or coordination with other sector activities or plans, with national sector plans, and with integrated coastal management plans is essential.

Conflict between different resource users may already exist in the aquaculture sector. Public involvement and participatory decision making, environmental assessment, cost benefit analysis, and other techniques that seek to identify and compare social, economic and environmental values, may bring into the open previously hidden differences in terms of development needs, and the values and aspirations of the various resource users and other stakeholders (Ellegard, 2000).

Parties and governments should be urged to adopt best management practices and legal and institutional arrangements for sustainable aquaculture, in particular through implementing Article 9 of the FAO Code of Conduct on Responsible Fisheries, as well as other provisions in the Code that deal with aquaculture, recognizing that it provides necessary guidance to develop legislative and policy frameworks at national, regional and international levels (FAO, 1997). Governments, scientists and fish producers organizations must assess the consequences of aquaculture for marine and coastal biological diversity and promote techniques which minimize adverse impact.

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A LOCAL HYPOTHESIS FOR THE DEVELOPMENT OF THE FISHERIES AND AQUACULTURE SECTOR IN FRIULI VENEZIA GIULIA, ITALY

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ABSTRACT

At present, the Italian fisheries and aquacultural sectors are characterized by economic weakness, increased costs and a reduction of natural resources that, mainly in fisheries, decreases profitability and employment. This situation clashes with the expectations of some areas, such as the “fish area” of the Friuli Region, which has a strong seafaring tradition. This project aims to promote the structuring of Grado and Marano lagoon enterprises into a district model, based on versatility and strictly connected with the natural productivity of the environment. This model gathers great strength from the strict (formal and informal) relationships in the area between enterprises and (public and/or private) local institutions, facilitated by their closeness and shared context. This form of co-management could be suitable for responding to market needs and transferring research and innovation to the local context. The study described assesses the main characteristics of establishing a fisheries and aquacultural district in the Friuli lagoon and explores opportunities for improving strategic and participatory approaches to planning – in two words: cooperation and competition.

Key words: *Italy, aquaculture, fisheries, fish district, planning*

Introduction

The Friuli Venezia Giulia Region borders the Northern Adriatic Sea for about 80 km and is characterized on the west by the lagoon of Marano and Grado, which is the main brackish water area of the region. The total surface of this lagoon is 15 250 ha, of which 2 425 ha are islands and sandbanks. It is bounded on the north by the low plain of Friuli, on the west by the Tagliamento River and on the east by the lands of the “Victory” reclamation. Its southern delimitation by the sea is provided by a string of islands which develop from the peninsula of Lignano up to the Primero Canal. This lagoon differs in several features from the other lagoons of the Northern Adriatic Sea, being the furthest north in the whole Mediterranean. Several streams discharge into it and it has numerous and wide mouths linking it to the sea. The result is that the lagoon of Friuli has the widest annual thermal range and, in general, the coldest thermal profile of all Italian lagoons, because of the frequent continental winds called the “Bora”, which comes from East Europe in the winter.

The oldest and still important activities in the lagoon are fisheries and aquaculture. However, their activities are facing increasing difficulties, due to several factors:

- environmental constraints;
- legal problems of management of the lagoon surfaces by fishermen;
- overfishing; and

- significant competition from other fisheries nearby.

From these problems follows the necessity to establish a policy for these sectors; one of the tools used could be the development of a “Fish District”.

The identification by the Region of a “district area” – a territorial economic-employment development system designed to promote and coordinate local enterprises, could create the conditions necessary for optimizing the use of the existing or potential technical, human and productive resources. It is an initiative designed to:

- innovate and develop productive activities (handicrafts and small-medium enterprises – SME) if specific economic indices (above all the presence both of local units and of manufacturing employees) reach levels higher than those previously determined by economists for the area under investigation; and
- settle business activities in areas characterized by high levels of unemployment, which have been caused by crises in their former activities.

In both cases delimitation of the area depends mainly on the structure of the local manpower.

The national government gives importance to these aims¹, as demonstrated by laws and a ministerial decree containing the goals and variables that the Regions have to refer to in defining these districts. In fact, a district can be considered as “a socio-territorial entity that is characterized by the active presence of both a community of people and a population of firms in one naturally and historically bounded area” (Becattini, 1989). The district can be defined as a community network and considered a complex organizational form.

The division of the regional territory into districts can be a useful tool, designed to allow the Region to define the main lines for the development, promotion and increased value of fisheries and aquaculture activities, and to ensure that they are in harmony with regional economic programming. The aim of this paper is to study the possibility of establishing a “Fish District” along the coast of the Friuli Venezia Giulia Region.

Materials and Methods

The area

The first step was to establish the borders of the Fish District. The parameters we used to define this economic-territorial system are those suggested by the laws in force, suitably adapted to the local situation. For this reason, it was necessary to make a thorough analysis of the territory, to avoid the possible inelasticity that might be caused by the implementation of criteria that often do not allow for local specificity².

We therefore postulated four possible cases for a fish district on the basis of decreasing historical fisheries background criteria (Table 1). These were:

¹ Here we consider the Law nr. 317 (5 October 1991) 'Interventi per l'innovazione e lo sviluppo delle piccole e medie imprese' that defines Industrial District territorial systems, geographically bordered and formed by adjacent areas, in which there is a high density of small firms, characterized by having the same productive specialization. The specific delimitation of the territory is under the control of the Region.

² This means the presence of the following features:

- fisheries or aquacultural activities consistent with the natural vocation of the territory and significant for the local economy;
- an homogenous historical identity;
- a consolidated integration between fisheries activity and other local activities; and
- the production of particular goods or services that are consistent with local traditions and innate talents.

1. Case 1: the three municipalities with the oldest fisheries background in the Lagoon;
2. Case 2: the same municipalities as in Case 1, enlarged with three other municipalities of the western side of the lagoon;
3. Case 3: the same municipalities as in Case 1, plus four other municipalities at the east side of the lagoon; and
4. Case 4: a larger area that included all the municipalities along the coast, some of them outside the lagoon but with historical fisheries background.

TABLE 1
List of municipalities considered in the four hypotheses for a “Fish District”

Municipality	Inhabitants	Surface areas (km ²)	Hypotheses and resultant surface areas (km ²)			
			Case 1	Case 2	Case 3	Case 4
Latisana	11 015	42.30		42.30		42.30
Lignano	5 695	16.21		16.21		16.21
San Giorgio di Nogaro	7 581	125.83		125.83		125.83
Marano Lagunare	2 197	90.26	90.26	90.26	90.26	90.26
Carlino	2 688	30.36	30.36	30.36	30.36	30.36
Grado	9 073	114.06	114.06	114.06	114.06	114.06
Aquileia	3 385	36.84			36.84	36.84
Staranzano	5 980	18.71			18.71	18.71
Monfalcone	27 223	20.52			20.52	20.52
Duino Aurisina	8 501	45.17			45.17	45.17
Total	83 338	540.26	234.68	419.02	355.92	540.26

The indices

For the definition of the Fish District we adopted the procedure of the regional law for “industrial districts”³ and “handicraft districts”⁴, using as a database the ISTAT Census of Industry and Services (ISTAT, 1991a), which is the most recent document on this topic at the moment⁵.

First model

For the definition of the productive divisions we referred to the classification of the economic activities ATECO 91, based on the revised EU classification NACE Rev. 1 (ISTAT, 1991b). In particular, although it concerns industrial districts, it referred to four operating parameters⁶:

³ Legge Regionale 11 November 1999 n. 27, in Friuli Venezia Giulia Region B.U.R of 17 November 1999 n. 46, Per lo sviluppo dei Distretti industriali.

⁴ Legge Regionale 22 April 2002 n. 12, in Supp. Extraordinary of Friuli Venezia Giulia Region B.U.R of 24 Aprile 2002 n. 17, S.S. 26 April 2002 n. 7, Disciplina organica dell’artigianato.

⁵ The ISTAT Intermediate Census of Industry and Services (ISTAT, 1996) unfortunately did not consider Section B – Fisheries, fish farming and related services – so we were obliged to consider the previous ISTAT Census.

⁶ The 5th variable proposed by law (number of employed in SME = >50 percent in the manufacturing activity of the specialization) was not considered as significant because all the enterprises of this activity are classifiable as SMEs.

1. Index of manufacturing industrialization of the local system (IWL) must be more than 20 percent above the regional datum (IWR)

Condition: $IWL/IWR = >1.2$

Where: $IWL = wml/wtl$
 $IWR = wmr/wtr$

wml = number of employees in the local manufacturing industry
 wtl = number of employees in the local industry
 wmr = number of employees in the manufacturing industry of the Region
 wtr = number of employees in the industry of the Region

2. Index of entrepreneurial manufacturing industry density of the local system (IED) must be higher than the regional average density (IRD)

Condition: $IED/IRD = >1$

Where: $IED = ulml/prl$
 $IRD = ulmr/prr$

$ulml$ = number of local manufacturing industry units locally
 prl = local population
 $ulmr$ = number of local manufacturing industry units in the Region
 prr = population of the Region

3. Index of productive specialization (ISL) must be more than 30 percent above the regional datum (ISR)

Condition: $ISL/ISR = >1.3$

Where: $ISL = wsl/wml$
 $ISR = wsr/wmr$

wsl = number of employees in the local specialization sector
 wml = number of employees in the local manufacturing industry
 wsr = number of employees in the sector of specialization in the Region
 wmr = number of employees in the Region's manufacturing industry

4. Level of manufacturing activity specialization employment (IWS) where the number employed in the specialized sector must be at least 25 percent of the total employed in manufacturing in the area

Condition: $IWS = wsl/wml = >0.25$

Where: wsl = number of employees in the local specialization sector
 wml = number of employees in the local manufacturing industry

Second model

The second model we used was that of the “handicraft district” and the zoning was made on the basis of the following parameters:

- A. the territorial reference area includes one or more neighbouring municipalities;
- B. the handicraft firms have legal or operating places of business in the area (defined under the letter A), and have homogeneous features of production, manufacturing, utilization and marketing of a product that is a prevalent activity of that area;
- C. the number of handicraft firms (in B) divided by the total number of handicraft firms located in the same territory is equal to or higher than the same ratio calculated for the whole Region, multiplied by 10;
- D. the number of handicraft firms (in B) divided by the number of residents in the same territory is equal to or higher to the same ratio calculated for the whole Region, multiplied by 10;
- E. the number of workers in the handicraft firms (in B) divided by the number of workers employed in all the handicraft firms located in the same territory is equal or higher than the same ratio calculated for the whole Region, multiplied by 10; and
- F. the number of workers in the handicraft firms (in B) divided by the total number of workers employed in all the manufacturing activities in the same territory is equal or higher than the same ratio calculated for the whole Region, multiplied by 10.

Definitions

For the purposes of this study we considered as a “manufacturing activity” the combination of section D “manufacturing activities” and section B “fisheries, fish farming and connected services” in ATECO 91 (ISTAT, 1991b). We also considered as a “specialized sector” the sum of section B and group 15.2 “processing and preserving of fish and fish products” (NACE Rev. 1).

Results and Discussion

First model

The variables for the Fish District according to the “industrial district” model are reported in Table 2. As can be observed, the four territorial hypotheses gave rather different values. In Case 1 the limiting variable is IWL (0.75), which is far below 1.2. All the other constraints, in particular the fourth (IWS = 0.89) are satisfied. The same is shown in Case 2: the IWL is <1.2 but all the other constraints are satisfied, including IWS (0.42).

When we considered the third and fourth hypotheses, the results were the opposite (Table 2). In both Case 3 and Case 4 the IWS was lower than the limit, while the IWL improved considerably, reaching the target of 1.2 in Case 3.

In the case of the final index (IWS >0.25) we must consider that, in our study, it cannot be so high as for the industrial sector because the number employed in the primary is far lower than in the secondary sector.

Second model

The definition of the Fish District (considering only Fisheries) considerably improved when we used the variables of the “handicraft district”. The conditions given in A and B were always satisfied for all the four territorial hypotheses, and are therefore excluded from Tables 3 and 4. The other conditions (Indices C, D, E and F) were satisfied in Cases 1, 2 and 3, but not in Case 4 (Table 3). In fact, in this final case, index C was less than 10.

TABLE 2
Indices obtained for the Fish District considering the variables of the “industrial district”

	Hypotheses			
	Case 1	Case 2	Case 3	Case 4
IWL ¹	0.75	0.67	1.20	1.03
IED ²	3.44	2.07	1.68	1.56
ISL ³	6.80	31.17	9.64	9.89
IWS ⁴	0.89	0.42	0.13	0.13

¹ IWL = Index of manufacturing industrialization of the local system

² IED = Index of entrepreneurial manufacturing industry density

³ ISL = Index of productive specialization

⁴ IWS = Index of manufacturing activity specialization employment

TABLE 3
Indices obtained for the Fish District considering the variables of the “handicraft district” (data obtained based on the fisheries industry only)

	Hypotheses			
	Case 1	Case 2	Case 3	Case 4
Index E ¹	70.15	23.15	15.11	10.51
Index C ¹	21.02	13.06	11.37	8.74
Index D ¹	249.79	253.62	256.10	259.93
Index F ¹	96.14	34.77	12.59	10.23

¹ See materials and methods for the indices

TABLE 4
Indices obtained for the Fish District considering the variables of the “handicraft district” (data based on the fisheries industry combined with the fish processing industry)

	Hypotheses			
	Case 1	Case 2	Case 3	Case 4
Index E ¹	7.30	9.42	8.05	10.16
Index C ¹	20.50	12.91	11.07	8.62
Index D ¹	249.62	255.22	255.55	261.15
Index F ¹	66.80	31.17	9.64	9.89

¹ See materials and methods for the indices

We therefore made a second simulation of this model, based on two activities combined: the fisheries industry and the fish processing industry together (Table 4). The results of this second elaboration are substantially the same, except for Index E, where the results were worse in all cases, being ten or below. The results for Index F were close, but still lower than the limits for Cases 3 and 4. Very high levels were found for Index D (the number employed in the sector compared to the population living in those areas) in all the cases investigated (Tables 3 and 4).

There are several different activities that are performed within the lagoon of Marano Grado and the coastal area considered for the Fish District. The oldest and most traditional are fisheries and valliculture. Recently mollusc farming has been added to these activities in specific areas held under concession from the Marano Lagunare municipality, or along the Trieste coast. Furthermore, several tertiary and industrial activities exist along the borders of the lagoon, often causing environmental impacts that are not sufficiently considered. In addition, we discovered more than 16 authorities that have more or less binding levels of decision, if not the right of *veto*, for any intervention or action in these areas. It is clear that the Region needs to develop an operational arm that enables the control of these areas and promotes their management, according to the productive pre-existing realities. The division of the regional territory into districts could be a useful tool to define the fundamental needs of the fisheries and aquaculture sectors of Friuli Venezia Giulia.

From the results obtained in this study it seems that it would be possible, on the basis of Regional Acts concerning the industrial districts, to institute a “Fish District” in the area under investigation, especially for Cases 2 and 3, which have values for most of the indices that fall within the fixed limits. Nevertheless, the less constraining conditions concerning handicraft districts would allow the Fish District to have a greater area (Case 4). This would ensure further sectorial productive diversification, because of the presence along the coast of mussel culture that is absent in the other Cases.

It seems logical for these areas to obtain official recognition through the institution of a District Committee, with the specific function of “establishing a local forum for discussion among the parties interested in local sectorial policy themes”. With this function in mind the activities promoted by the District Committee would be principally directed towards:

- supporting and coordinating dialogue and negotiations among the various productive activities;
- supporting and coordinating the initiatives designed to promote the commerce and image of the territory;
- promoting cognitive and informative activities aimed at studying and monitoring problems of economic, social and environmental character;
- supporting the aggregation and comparison of various local interests, with the involvement of all stakeholders;
- promoting the coordination of different management policies and territorial development with a view to obtain a general increase in available resources; and
- supporting the initiatives of negotiated programming and area agreements within the specific territory.

It seems clear that satisfying the requirements for the foundation of a Fish District for Friuli Venezia Giulia Region requires a selection from the four proposals considered. This should be based on the existence of enterprises that are motivated to invest in new knowledge, research and technologies, in cooperation with Scientific and University Institutes and with producers associations.

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INTEGRATING STAKEHOLDER KNOWLEDGE INTO INTERDISCIPLINARY SCIENCE: LESSONS FROM FISHERIES FOR AIDING THE DEVELOPMENT OF SUSTAINABLE MANAGEMENT AND POLICY FOR AQUACULTURE

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ABSTRACT

Case studies are presented to illustrate how qualitative information from stakeholders (in this example, Scottish fishers) can aid the development of a sector through advancing debate on its management, policy and science. The Scottish demersal fishing industry is a good example because, like some types of aquaculture, it represents an industry in the UK that is currently facing financial crisis. In contrast to aquaculture, the number of people involved in marine capture fisheries globally is declining; however, competition for space in coastal waters is increasing. Balancing changes that affect people directly, such as imposing management measures that directly affect employment opportunities requires an understanding of stakeholder attitudes, priorities and career aspirations, among others.

Integrated Management Plans (IMP) that have been devised using multi-disciplinary expertise and that adopt an inter-disciplinary approach are recommended as a way forward to help the aquaculture industry to achieve its full potential. The recommendations of the European Commission for Integrated Coastal Zone Management (ICZM) are illustrated as a process to help inform formulation of an IMP and aid sustainable aquaculture development. The theory behind ICZM is relevant to all types of aquaculture (freshwater, brackish and marine). ICZM promotes stakeholder involvement as a way to build consensus and engender environmental stewardship through, for example, partnerships between stakeholders and all interested parties.

The aquaculture industry needs to improve communication and participation of actors and players, in order to prevent a similar situation occurring to that presently experienced in the UK fisheries sector, where a high level of distrust among stakeholders, managers, scientists and politicians exists. A prerequisite for effective management is to understand attitudes, behavior, culture, decision-making processes, motivation and perceptions of stakeholders with a view to formulating policy that responds to and is supported by those it targets.

These studies show how natural and social scientists can work effectively as a multidisciplinary team to help the aquaculture industry to respond to emerging issues and new developments. Finally, recommendations for improving communication between interested parties are discussed.

Key words: *United Kingdom, aquaculture, fisheries, governance, ICZM, interdisciplinary, local knowledge, management, policy, stakeholder participation*

Introduction

The main aim of this paper is to demonstrate how applying qualitative information from stakeholders can help to inform developments in the management, policy and science of aquaculture. Mounting evidence of the benefits from stakeholder participation is encouraging as this has led to a growing number of studies on the role of alternative (sometimes called “soft data” or indigenous knowledge) in management, particularly in fisheries but less so in aquaculture. Some of this work has been conducted by social scientists, however, often in isolation from natural scientists and *vice versa*. Few research projects have adopted a truly interdisciplinary approach where social and natural scientists work effectively as a team

combining their skills in complimentary ways. In many instances, researchers from a range of disciplinary backgrounds find it difficult to work well in a group, partly due to differences in methodological approaches and dissimilar usage of technical language. Interdisciplinary studies in aquaculture remain to some extent at the concept stage.

To address this it is important that, prior to the start of a project with a participatory component, the methodological approaches have been well researched and agreed by all those involved. For the case studies described in this paper, an extensive period of consultation was undertaken with experts with backgrounds in fisheries science, anthropology, management, economics, sociology, statistics and policy, before the experimental design was agreed. This was to ensure that a representative level of stakeholder participation was attained, in addition to exploring how to motivate stakeholders to be involved in the study and how to maintain their interest. The initial time spent investigating and understanding the array of approaches that could be used to collect stakeholder information proved valuable because 80 skippers (stakeholders targeted) were involved in the study, and each provided useful data.

Stakeholder information, although valuable, is only part of the criteria needed for developing effective management and policy. An Integrated Management Plan (IMP) that encompasses the cultural, economic, environmental, legal, political, scientific, social and technological aspects is the best way forward for promoting sustainable aquaculture development. An interdisciplinary approach is needed to formulate IMPs in a meaningful way; a good example of a process that adopts multi-disciplinary expertise using this approach is Integrated Coastal Zone Management (ICZM). The theory and practice of ICZM builds strongly on stakeholder participation and is a useful process from which the aquaculture sectors can learn lessons. This paper describes IMPs, ICZM and real life case studies where stakeholders played a central role.

Integrated Management Plans

The necessity for Integrated Management Plans (IMPs) to address the unique problems of aquaculture arises from the need to integrate the management process of the land and water resources that support this activity. In most countries, legislation (Van Houtte, 2001; Stead, 2003; 2005) for these two environments has been treated in isolation to each other, which has caused problems for planning, development and management of aquaculture. IMPs are one approach that can be used to ensure that for example, legislation pertaining to aquaculture is considered from both a landward and seaward perspective. It is important that the geographical area, local communities, political and social systems, and experiences of aquaculture are understood before developing an IMP.

Traditionally, aquaculture was categorized under capture fisheries in terms of its management administration. Also scientific advice, policy and legislation matters related to aquaculture have largely been dealt by centralized administration systems, e.g. by Ministries for Fisheries and Agriculture. This means that aquaculture has not always been treated in isolation to fisheries or given due consideration; hence discussions on relevant issues have on occasion led to delays in action needed in the aquaculture industries. It is noteworthy that in 2001, the Food and Agriculture Organization of the United Nations (FAO) set up a COFI (Committee on Fisheries) Sub-Committee on Aquaculture to reflect the growing importance of the aquaculture industry.

A successful IMP can only be developed through an interdisciplinary approach with input from experts with different backgrounds combined with stakeholder participation. Decision-making between all involved must be built on consensus as this is the basis for formulating good management. Aquaculture is an international activity and it is important for individual countries to share experiences of good and bad practice. This could then help to develop IMPs

as a framework in which international audiences could communicate experiences in a standardized format that takes account of local and national differences and similarities. This EIFAC symposium is an ideal forum to promote exchange in lessons learnt from suitable examples from around Europe. ICZM is a further example on which an IMP can build a framework, as it adopts a holistic and inter-disciplinary approach to management. Some of the work on ICZM to date also includes aquaculture (see Stead, Burnell and Gouletquer, 2002, for a review).

Integrated Coastal Zone Management

Integrated Coastal Zone Management (ICZM) came to prominence following Agenda 21 (UN, 1993) and the Rio Earth Summit (Kay and Alder, 1999). Both of these international events raised the awareness of working in an interdisciplinary way to identify and overcome environmental (and coastal) problems. There have been a variety of definitions proposed for ICZM but it is beyond the scope of this paper to detail these; Burbridge and Humphrey (2003) give an overview of European and international perspectives on ICZM, while Burnell *et al.* (2001) and Stead, Burnell and Gouletquer (2002) and Stead (2005) discuss aquaculture in relation to ICZM. Many are familiar with the concept of ICZM but it is a concept that has rarely been implemented successfully in practice. Despite this, at the international and European levels, there are proposals to encourage the implementation of ICZM principles (e.g. European Commission, 2002b). This has implications for the management of aquaculture, especially marine based production.

Interdisciplinary approaches are widely discussed but few examples exist in reality, especially in relation to aquaculture, that convincingly demonstrate the benefits that this approach can offer. This in part is due to some fundamental issues that need to be resolved including ways to improve how experts from different disciplines work together effectively. The following steps can foster a more productive environment for interdisciplinary teams to work in:

- agreeing clear project aims by all at the beginning;
- developing a common language and an understanding of diverse methodological and analytical techniques;
- ensuring flexibility in study design;
- showing willingness to cooperate; and
- exhibiting openness and enthusiasm.

The principles and practice of ICZM specifically recognize the complex relationships between land and sea environments. This is particularly relevant for coastal aquaculture, where both terrestrial and marine environments are used and conflict resolution methods between a range of resource users is often required. Aquaculture needs to be managed in a way that takes account of all its activities, impacts, needs and considerations – IMPs can be specifically tailored to do this along with other economic, environmental and social issues (Stead, 2002). There are a growing number of examples where various forms of IMPs are being employed; for instance, in Scotland, some of the Local Authorities in the Scottish Highlands and Islands have produced Framework Plans that encompass aquaculture interests and ICZM principles. Keys to any successful management plan that impacts on local communities and surrounding areas include effective communication and participation of representative stakeholders. Experience has shown that initial involvement is usually high; however, maintaining the participation and motivation of all interested parties can prove difficult unless clear goals are proactively pursued and achieved.

The next section describes two related studies where methods were designed to engage stakeholders effectively to share ideas and views on various aspects of management in relation to their industry.

Background

The case studies presented, briefly describe the preliminary findings of a project that examined the role of the knowledge of local fishers about fisheries science, management and developments in policy.

In Europe, interdisciplinary approaches to management, especially in coastal areas, are being promoted through policies such as the Common Fisheries Policy (European Commission, 2001; 2002a) and ICZM (European Commission, 1999; 2000; 2002b). Stakeholder participation is acknowledged as a key component to formulating and implementing successful management and policy. The findings of an interdisciplinary research project which examined how qualitative information from stakeholders (in this case fishers) can be used to inform fisheries managers, with a view to improving governance, is described. Lessons from these studies can be applied to similar projects investigating ways to improve sustainable management of aquaculture. The studies described here are a brief overview of research conducted with Anne McLay (Fisheries Research Services Marine Laboratory Aberdeen, Scotland) and Tom Rossiter (former project Research Assistant) between 2001 and 2003.

Aims

The main aims of the research were to:

- explore the knowledge of fishers and their views on a range of topics related to fisheries management, policy and science;
- develop study methods to collect and analyse data; and
- investigate how indigenous knowledge can be used to improve governance.

The research focused on the Scottish demersal fishing fleet, a sector of the industry considered to be in crisis at the time interviews were conducted. With a view to investigating methods in which data on the above can be applied to help improve fisheries management, policy and science-based information, the surveys were designed to seek the views of fishers on the following:

- factors affecting decision making about fishing and fishing effort – implications for policy;
- attitudes and responses to management measures; and
- fish biology and fish stocks (life history, abundance and distribution) – contribution to scientific knowledge.

Methods

Face-to-face, semi-structured interviews of 80 skippers (55 in 2001 and 25 in 2002) of demersal boats in the Northeast of Scotland were conducted at or near the following ports, Aberdeen, Fraserburgh and Peterhead. The Northeast area was selected because it accounts for approximately 60 percent of fish landings in Scotland.

All interviews were recorded using an unobtrusive mini disk recorder (Sony MZ-R700 and Sony EMC 717 microphone); permission was sought beforehand from the skippers (only one declined). The recordings were transcribed verbatim and transcripts were analysed using a

qualitative data analysis package (QSR NVivo 1.3). The following quantitative descriptive statistical techniques were used to summarize the responses of skippers to factors that affected their decision making about fisheries related activities: Principal Component Analysis (PCA), Redundancy Analysis and Discriminant Analysis (DA).

Case study 1

In April 2001, a pilot study was conducted on five skippers to trial questions and techniques for semi-structured interviews. The survey was reviewed and revised in view of the findings of the pilot study and a further 50 interviews were conducted between April and November 2001.

Case study 2

In 2002, a follow-on study focused on collecting more detailed information on the local knowledge of fishers about fish ecology. This second study (25 skippers were interviewed between March and October 2002) extended the semi-structured interview technique employed in 2001 with the added use of maps and charts. This led to the development of a database with the longer term aim of linking it to a Geographical Information System to store and aid understanding of the data collected.

Results

The diverse range of responses by skippers to the questions posed highlighted a high level of variation between individuals.

The findings from Case study 1 demonstrated that the northeast demersal skippers interviewed shared common backgrounds – all but two originated from the area. Once their initial lack of confidence was overcome it was evident that fishers are a useful source of knowledge on a diverse range of issues important to the development of effective and responsible fisheries governance. In addition, the skippers were willing and interested participants in the study.

Factors affecting decision making about fishing and fishing effort

The initial pilot survey in Case study 1, when five skippers were interviewed, identified a number of factors that were considered by them as part of their decision making process about fishing and fishing effort. In order to quantify this, 50 further skippers were asked to give a value between one and four – with one being very important and four being of no importance – to each of the 15 factors shown in Table 1 and to indicate if each of the factors were more, similar or less important today than in the past. This helped to ascertain which factors have changed the most over time in the decision making process of skippers.

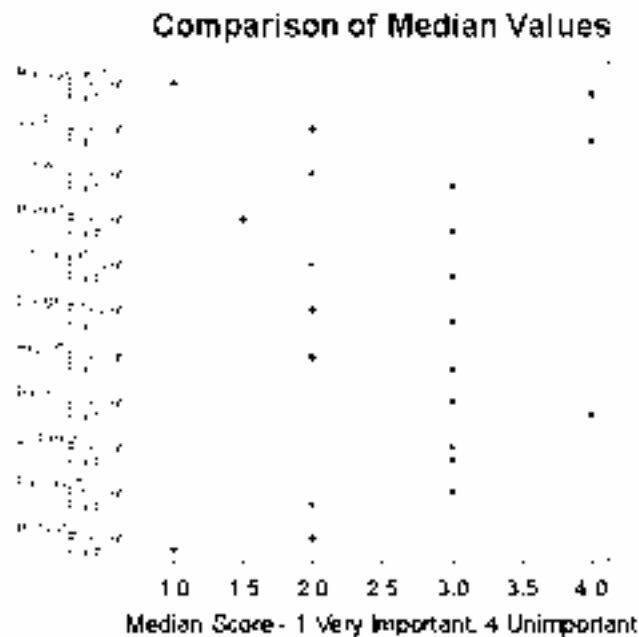
TABLE 1
Factors important in the decision making of skippers

Bank	Conservation	Costs
Crew experience	Dangerous conditions	Distance to travel
Familiarity with fishing rounds	Intuition/risk	Management Restrictions
Market conditions	Peer pressure	Personal motivation
Recent trip	Reports	Tides and weather

PCA showed that only 28 percent of the variation in the responses of skippers to the 15 factors could be represented by the first two principal components. This indicates a low level of correlation between responses by the individual skippers and highlights a high level of inter-individual variation of the views of fishers – no two skippers gave the same answers. Figure 1 illustrates that the two main factors considered to have become more important over time were management restrictions and costs. Familiarity with fishing grounds and personal motivation had become less important with time.

FIGURE 1

The responses of skippers to some of the factors considered in their decision-making

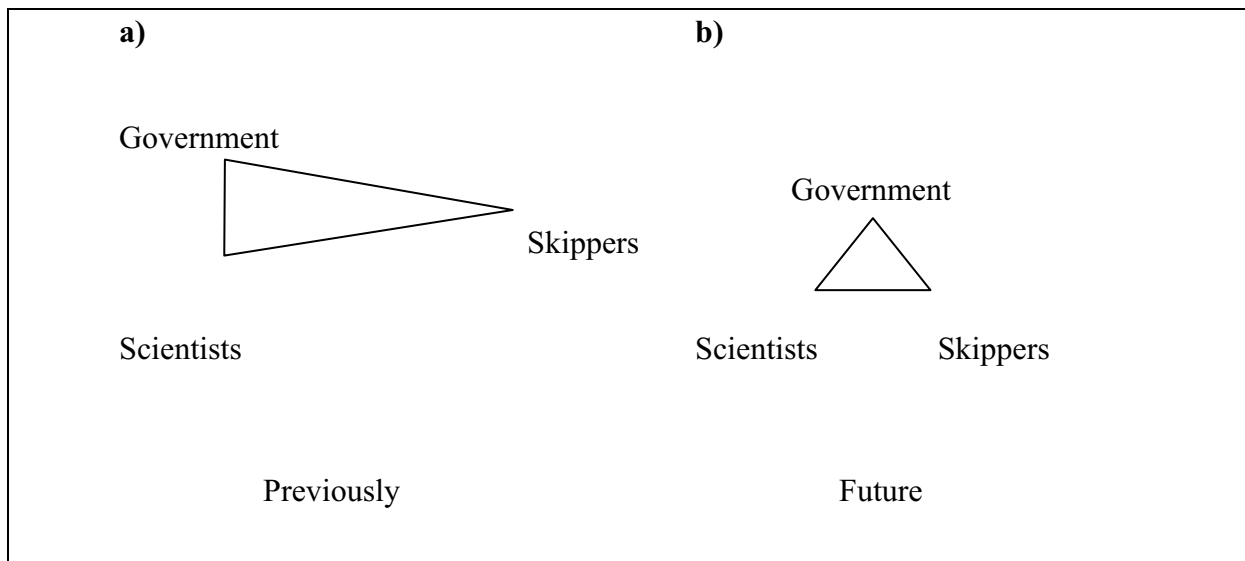


DA was also performed on the responses of skippers to the 15 factors (in a past and present context) considered in making decisions about fishing and fishing effort. The results of this technique highlighted management restrictions, crew experience and market conditions as being more important today than in the past compared to personal motivation, which is now less important than before.

Attitudes and responses to management measures

The perception of skippers about the current fisheries management structure is of a triangular system, with Government, Scientists and Skippers representing the corners (Figure 2). The proximity of each corner to the next represents the closeness of the relationship between the different groups. In the past the skippers noted that the points which represent scientists and “managers” (government) have been close together while the point representing the skippers has been much further away (Figure 2a). Given such a system the skippers see their negotiating position as being weak and in order to gain more influence they need to move closer to one or even both parties (Figure 2b). The skippers view the scientists as being their best ally, but in both cases they see the need to strengthen their position and become more involved in the management process.

FIGURE 2

Anticipated change in management system relationships

The skippers proposed that any future management system must be both fair and transparent, giving everybody the same opportunities while managing the industry in a sustainable manner. From the perspective of skippers this would give every fisher the same chance; if they are unable to survive then they would only have themselves to blame and no case for recourse. Linked to this, some skippers noted that community spirit and values had been eroded along with an observed increase in selfish behavior by some fishers.

Some of those interviewed also suggested that the management of the fisheries industry should move away from the current bias on biological (scientific) information to a more balanced approach that also considers social and economic factors. Skippers feel that this is the way forward for developing policy and effective governance with the prerequisite of including their (indigenous) knowledge at the start.

Fish biology and fish stocks (life history, abundance and distribution)

The skippers acknowledged that they had played a pivotal role in the decline of the industry but suggested that other factors were also responsible, for example climate change. The findings of Case study 1 agreed with other similar studies in showing that skippers have an in-depth knowledge of fishing grounds, spawning areas and other ecological data. The main observations made by the skippers included:

- an overall general decline in fish stocks over the last decade;
- longer term cyclical changes, reducing the numbers of cod in inshore waters, identification of spawning times and areas;
- changes in fish feeding through noted contents of stomachs;
- increased numbers and area of capture for saithe; and
- a lack of larger haddock.

Some skippers also observed small changes over time that mimic scientific observations; therefore it is clear that skippers have a wealth of information that can be used to improve the management of fisheries. These findings were the rationale for the follow-on study in 2002 (Case study 2) which collected more detailed traditional ecological knowledge than in 2001, through the added use of maps and charts.

The findings from Case study 2 illustrated that meaningful data can be collected from skippers with potential applications for stock assessment of fisheries, which has to-date been largely based on scientific information and methods. Although only a limited number of skippers were interviewed (n=25), it was possible to construct simple density plots, in addition to identifying important spawning and fishing areas that broadly agreed with scientific based models.

Conclusions

Overall, the two case studies confirmed that skippers have a wealth of valuable knowledge that can help to improve the governance and management of fisheries. In addition, the majority of skippers interviewed showed no hesitation in disclosing information about their fishing practices. Many were interested and willing participants in the studies, once their initial lack of confidence had been overcome. The choice of interviewers and interviewing techniques employed are critically important to ensure that relevant and useful data that can be applied to fisheries management, policy and science is collected.

Collecting information directly from skippers *via* entrusted individuals/methods is an area that should be developed, so that more cost-effective ways than scientific surveys (for example) can be employed to collect the data needed for fisheries management. In addition, semi-structured interviews aided the collection of data on a diverse range of topics related to the fisheries industry; in particular this technique delivered a better understanding of the cultural, economic and social issues facing fragile coastal communities dependent on fishing.

The interviews for Case study 2 coincided with the announcement of the European Commission on its proposed formation of Regional Advisory Councils (RACs) as a means of increasing stakeholder participation in fisheries management. All 25 of the skippers interviewed agreed that a move towards local or regional management was a step in the right direction; however, 20 (80%) stated they did not wish to get involved personally in the work of RACs – rather they saw this as a task for fisheries industry representatives.

Discussion

Stakeholder participation is a key element of successful governance. The findings of the case studies summarized demonstrate that stakeholders can help to advance management, policy and science if appropriate methods are employed to promote dialogue. Understanding the attitudes, behavior, considerations, decision-making processes, issues and perceptions of stakeholders directly involved in a sector is essential for developing informed advice. Failure to take account of qualitative aspects of local knowledge can lead to the development of policies that do not reflect the needs of those that are targeted.

Furthermore, policy makers need to be aware of conflicts in coastal areas where competition for space is an issue. To illustrate this point for aquaculture, the location of cages for finfish production or the static equipment used to rear shellfish can sometimes exclude other coastal resource users like fishers. This can lead to conflicts between stakeholders that, if left unaddressed, can sometimes result in dire consequences. Take for example, equivocal reports of salmon cages being vandalized that lead to the release of farmed escapees into the marine environment, expensive repairs and loss of income to the finfish farmer. Other members of the community can also be affected, such as the salmon farm employees, fish processors, transporters and other ancillary service providers. If local stakeholders had been consulted about the set-up of the marine salmon cages in the first instance, and their support solicited, then incidences of this nature may have been avoided. Unfortunately, similar occurrences

continue. IMPs and ICZM are both useful frameworks that can help coastal resource managers to mitigate the impacts of such events on coastal communities (Stead, 2005).

Stakeholders will respond better to management measures that balance their needs with actions required to maintain sustainable levels of aquaculture development. The governance of aquaculture could be improved, especially in light of the recent increase in negative media about the industry (Stead, 2005). To help counter poor publicity the aquaculture industry should focus on the following principles when advancing management, policy and science:

- accountability;
- coherence;
- effectiveness;
- openness; and
- participation.

Demonstration and application of methods that can achieve effective stakeholder participation is an important prerequisite for a sustainable industry and is the key to improving confidence within and outside the aquaculture sector.

The aquaculture industry can help itself to reach its full growth potential through the various sectors of the industry working together instead of against one another (e.g. finfish versus shellfish farmers). In the fisheries industry, there has been a culture of poor communication and coordination within the sector that has partly contributed to its poor image (Stead, in press). Similarly, there have been conflicts between fisheries stakeholders and other coastal and marine resource users, as is the case with aquaculture stakeholders. The northeast of Scotland has been proactive in addressing this threat to the development of its fisheries industry by setting up the North East of Scotland Fisheries Development Partnership (NESFDP). This successful organization boasts a broad membership that includes representatives from the following:

- business enterprise groups;
- colleges and universities;
- councilors from the various constituencies;
- media;
- government;
- Members of the European and Scottish Parliaments;
- onshore and offshore sectors;
- other maritime sectors such as harbors and ports; and
- policy makers.

The whole partnership meets approximately twice a year, while a subdivision known as the strategy working group meets more regularly to consider particular needs and issues as and when they arise. The NESFDP has been effective in promoting communication and coordination, and in engaging involvement and support both horizontally and vertically. Good attendance at the meetings has led to many productive discussions and the resolution of potential conflicts of interest. This partnership is an excellent role model for other areas in the UK, as well as in other countries, to consider.

This paper has provided an insight into the potential value of actors and players involved in aquaculture working more closely with stakeholders, or at least being made aware of how those involved in the industry make their decisions on their respective activities. The aquaculture industry needs to address the current and future environmental and socio-economic challenges facing both developed and developing countries. The complexities in

managing the development of aquaculture in conjunction with demands from other resource users have led to the need for experts with advanced knowledge and skills in both the natural and social science disciplines. Training that adopts an interdisciplinary approach to the study of integrated management needs to be encouraged, along with an increase in the number of individuals that have experience of both landward (communities) and seaward (sustainable aquaculture production). Knowledge of the cultural, economic, environmental, legal, political, scientific, social and technological dimensions of aquaculture is fundamental for long-term sustainable development.

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Van Houtte, A. 2001. Establishing legal, institutional and regulatory framework for aquaculture development and management. In R.P. Subasinghe, P. Bueno, M.J. Phillips, C. Hough, S.E. McGladdery & J.R. Arthur, eds. *Aquaculture in the third millennium*. Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand, 20-25 February 2000. p. 103-120. Bangkok, NACA, & Rome, FAO.

REVIEW OF PRODUCERS ASSOCIATIONS AND THEIR ROLE IN AQUACULTURE DEVELOPMENT IN EASTERN EUROPE

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ABSTRACT

There have been substantial changes in the aquaculture sector in Eastern Europe in the past ten years of the transition into market economy. Parallel with privatization, a need for a new type of cooperation among farmers has emerged. In spite of recognized needs, the level of development of farmers associations is still low in most Eastern European countries. In some, the previous organizations (e.g. associations of state farms or cooperative farms) served as a basis for the development of new types of farmers associations. The necessity of coordinated actions and joint representation of fish farmers is increasing and positive examples from the activities of existing farmers associations also encourage the establishment of new ones. The paper provides an overview of the status of Eastern European fish farmers associations, and discusses their role in aquaculture development.

Key words: Eastern Europe, aquaculture, cooperation, development, economic transition, farmers associations

Background

The last ten years have brought substantial changes in Eastern Europe on both political and economic levels. The laws, regulations and measures issued to implement political decisions led to radical changes, even in aquaculture. Fish farms had to overcome the difficult process of transition to a market economy, during which their characteristics and the market for their products drastically changed. The process of transformation was significantly deterred by the fact that most farms had first to solve their liquidity problems that arose simultaneously with the change in the political system, due to economic difficulties. In addition, farms had to operate in continuously worsening market conditions. Compared to the previous times of planned economy, when they could base their production on secure state orders, they now had to do their work in conditions of increasing competition. The process of privatization eliminated most of the previously existing large state-owned fish farms, and led to the appearance of several new, privately owned and family enterprises. During this process, the assets of the existing farms were often acquired at low prices by companies or private owners. Many of these were subsequently unable to utilize their capacities or warrant their profitable operation due to the financial resources and the low level of production. However, in spite of their unsuccessfulness, they worsened the market situation of other farms.

In addition, the policy-makers of several Eastern European countries, especially the landlocked ones, still regard fisheries and aquaculture as a low-priority sector of the national economy.

As a result of all these factors, aquaculture producers in these countries had to realize that they needed a new type of cooperation, which could allow them to act jointly to achieve their common objectives. Obviously, this process did not happen at the same time in the various countries of the region. There are some states like the Czech Republic, Hungary or Poland, where the farmers associations are well-organized, strong and active at both national and international levels. However, in most Eastern European countries the level of development of

these associations is still low, in spite of the recognized need; in others their formation is only just beginning. The list of producers associations we know of currently, and their contact information, is summarized in Table 1.

In this paper we provide a brief overview of the state of development and the characteristics of the producers associations in Eastern European countries.

Development of Farmers Associations in Eastern Europe

Farmers associations in Eastern European countries are at very different stages of development. In some countries there are no such organizations and even the structural reorganization of the fisheries sector, which would create the fundamental conditions for their development, is only just beginning. In the Republic of Belarus, for instance, the 20 major fish farms are owned by the state and operate under the authority of the Ministry of Agriculture. Although their transformation into stock companies has been under process since 2003, the state remains the majority shareholder.

In other countries some kinds of producers associations exist, but they are organized in a top-down direction and are run by the state. An example of this is the Association of Fish Farms of Inland Waters of the Ukraine, which is an affiliation of the State Department of Fisheries. A further example is the State Cooperative Association for Fisheries (“Rosrybkhov”) in Russia, which serves as an umbrella organization for over 700 state-owned or private aquaculture enterprises. Currently, the organizations united by the Rosrybkhov produce over 90 percent of the total production of intensive and pond farms.

Bulgaria represents a further stage in the development of aquaculture producers associations; three such associations have been founded and the formation of a fourth one is in progress. The oldest of these is the National Association of Fishery and Aquaculture in Bulgaria (“Aquafish-BG”), which was established in 1998 and now (in 2004) has 36 members including 25 leading Bulgarian aquaculture producers, fish processing and trading companies and 11 independent experts of the sector. The main objectives of all three existing associations, i.e. the Aquafish-BG, the Fish Producers Association (BG-Fish), which was created in 2002, and the Bulgarian Fish Association, are generally similar. All aim at:

- protecting the commercial, social and other rights of their members and the fisheries and aquaculture sector as a whole;
- improving the national fishery and aquaculture legislation and adapting it to the EU Common Fisheries Policy;
- strengthening the position of Bulgarian producers on the domestic and international market; and
- improving the international relationships of the sector by closely cooperating with international organizations and participating in international fishery-related events.

The most developed fish farmers associations can be found in three new member states of the EU – the Czech Republic, Hungary and Poland. The oldest of these organizations is the Polish Fishery Association, which was established in 1918, but its activity was suspended in 1939 and it was not reactivated until the first half of the 1990s. Now it has its head office in Poznan and has nine regional divisions. The most active division is the Polish Trout Breeders’ Association, which has been a member of the Federation of European Aquaculture Producers (FEAP) since 1996. The main fields of activity of this association are the organization of annual salmonid farmer meetings and the monitoring of Polish trout production.

TABLE 1
Eastern European Fish Producers Associations

Country	Name of Association	Address
Republic of Belarus	Department of Melioration and Water Management, Ministry of Agriculture and Food of Belarus	220029 Minsk, Kommunisticheskaya ul. 11, Belarus
Bulgaria	National Association of Fishery and Aquaculture in Bulgaria The Fish Producers Association Bulgarian Fish Association	3 Luna Str. 4003 Plovdiv, Bulgaria E-mail: nkissov@spnet.net ; aquafish_bgass@abv.bg 1756 Sofia, Technical University, bl. 7, vh. 6 (NTM), Bulgaria E-mail: reyafish@mail.com 3 Industrialna Str. 8000 Burgas, Bulgaria
Croatia	Croatian Chamber of Commerce, Section Aquaculture	Mari Mirna, Giordana Palliage 4, 52210 Rovinj, Croatia E-mail: marimirna@pu.tel.hr
Czech Republic	Czech Fish Farmers Association	495/58 Pražska, 371 38 České Budějovice, Czech Republic Website: www.rybsdr.fish-net.cz ; E-mail: RYBSDR@pvtnet.cz
Estonia	Estonian Fish Farmers Association	5 Kaluri tee, 11712 Harju county, Viimsi, Estonia Website: www.ngonet.ee
Hungary	Hungarian Fish Producers Association	4/b Vöröskő u. 1126 Budapest, Hungary Website: www.haltermosz.hu ; E-mail: iroda@haltermosz.hu
Latvia	Latvian Crayfish and Farmers Association	7-6 Alberta Str. LV-1010 Riga, Latvia E-mail: earens@latnet.lv
Lithuania	Association of Lithuanian Fish Product Producers Association of National Aquaculture and Fish Product Producers	Nemuno St. 42, LT-93277, Klaipeda, Lithuania Phone: (46)-345045 Website: www.portofklaipeda.lt ; E-mail: klaipzvejas@takas.lt Konarskio St. 49-602, Vilnius, Lithuania Phone/fax: +370 6 2161626 E-mail: akvavit@takas.lt
Moldova	Propiscicola Association	E-mail: pfid@cami.com
Poland	Polish Fishery Association (Polish Trout Breeders Association)	ul. Winiarska 1, 60-654 Poznan, Poland Tel/fax: (061) 842 5134 (office), (061) 866 5510 (President). Website: www.aquapoland.com ; E-mail: ptryb@wokiss.wlkp.pl
Romania	“ROMPESCARIA” Association of private fish producers	Str. Dr. Alexandru Marcovici, nr.2, OP1, Cp. 813, Sector 1, Bucuresti, Romania Tel/fax: 004021/314.62.94 Website: http://www.agroal.ro/rompescaria/rompescaria.htm
Russian Federation	State Cooperative Association for Fisheries “Rosrybkhoz”	18a Ermolaevskiy pereulok 103001 Moscow, Russia
Ukraine	Association of Fish Farms of Inland Waters of Ukraine	45a Artema str., 04053 Kyiv, Ukraine

The Czech Fish Farmers Association, consisting of 60 members, and the Hungarian Fish Producers Association with 109 members, are also member organizations of the FEAP and are active, both nationally and internationally. In these countries previous organizations (e.g. associations of state farms or cooperative farms) served as a basis for the development of new style farmers associations.

In the following section of this paper, we provide an overview of the operation and characteristics of a relatively developed Eastern European farmer association, based on the example of the Hungarian Fish Producers Association.

The Hungarian Fish Producers Association: a Case Study

The Hungarian Fish Producers Association represents the professional interests of the Hungarian fisheries sector. It was established in 1990 as the successor of the Organization of Fisheries Cooperatives, which was founded in 1957. Since 1990 all natural persons and legal entities (or their affiliated organizations) that are engaged in fisheries-related activities independently and with business purposes can belong. The Association had 109 members in 2004, which were operating about 16 400 ha of fish ponds (72 percent of the total fish pond area); it therefore represents more than three-quarters of the Hungarian fisheries sector. The governing bodies of the Association are the General Assembly, the Board, the Control Commission, the branches and the ad hoc or permanent commissions.

Two important organizations are affiliated to the Association – the Fish Product Council and the Carp Breeding Branch. They cooperate with the association in organizing the biological and economic bases of national fish culture. The Fish Product Council suggests price limits, coordinates marketing activities between producers, processors and traders, and provides information to members. The Carp Breeding Branch, in close collaboration with the Institute for Agricultural Quality Control, the Ministry of Agriculture and Rural Development, and the Research Institute for Fisheries, Aquaculture and Irrigation, is an important player in the planning and implementation of carp breeding programmes and standardized carp performance tests. It also assists the productive activities of the members by providing them with technical advice.

The Hungarian Fish Producers Association owns a fingerling production pond farm in Dinnyés, which is in close cooperation with several universities and state research institutes, and actively participates in putting the results of fisheries science into practice. The pond farm provides stocking material of reliable quality to Hungarian producers and plays an important role in the organization of live fish exports.

The main objective of the Association is safeguarding and emphasizing the interests of fish producers. Therefore, the basis of its work is communication with state organizations for fisheries, governmental and non-governmental bodies for environmental protection, international fisheries organizations, the media and the people.

The Association regularly organizes professional forums to discuss the strategies and actual problems of the sector. It also provides advisory assistance to its members not only in legal, environmental and marketing issues but also in the preparation of various applications for subsidies and funds. The Association has launched a Marketing Communication Programme aimed at increasing fish consumption, with special regard to locally produced fish products.

The Association is also responsible for the maintenance of international contacts with relevant organizations for the benefit of the members. It organizes study tours abroad, which not only contribute to the professional development of its members but also strengthen their international relationships. The Hungarian Fish Producers Association became the member of the FEAP in 1999.

Conclusions and Perspectives for Development

The necessity for coordinated actions and joint representation of fish farmers is increasing. Positive examples from the activities of existing farmers associations also encourage the establishment of new associations. However, there is still much to be done in this field. Several countries have only just begun the organization of their farmers associations; the experiences of the already existing foreign counterparts will help them to avoid the mistakes that the latter may have made.

The situation of the existing associations is often far from ideal. They frequently struggle with institutional and organizational problems, indifference on the part of policy makers and economic difficulties. The international cooperation and exchange of both information and experiences are impeded by the inadequate availability of means of communication (Internet, etc.) and language barriers, which are especially characteristic for the former Soviet republics where the most spoken foreign language is still Russian.

Improvements in this situation need, first of all, stabilization of the economic situation and creation of the fundamental material and institutional background for the operation of such associations. Another important requirement is improved cooperation and information exchange between the farmers associations of the Eastern European region. This could draw the attention of the new associations to the possibilities of exchanging proven success stories and the mistakes and traps to avoid.

Having recognized this situation, the Hungarian Research Institute for Fisheries, Aquaculture and Irrigation (HAKI) initiated the creation of a network that would promote cooperation and information exchange between the fisheries-related institutions and organizations of the region. The Network of Aquaculture Centres in Central-Eastern Europe (NACEE) was established in 2003 and provides a good framework for solving common problems and promoting the development of fisheries in the entire region. To facilitate communication and recognize the linguistic specificity of the region, the NACEE has two official languages – Russian and English – and it undertakes the mission of bridging the gap and acting as a mediator between the fisheries-related organizations of the Eastern European countries and international organizations (e.g. FAO, FEAP, NACA).

CÉPRALMAR, AN EXAMPLE OF A REGIONAL PARTNERSHIP

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ABSTRACT

A distinctive feature of the Languedoc-Roussillon coastal region (French Mediterranean) is the presence of 28 000 ha of brackish water lagoons, the site of important fisheries (euryhaline fish, shellfish) and aquaculture (fish and shellfish farming) activities. Created in 1981, Cépralmar is a consulting body responsible for proposing and implementing a policy of support for those sectors. All of its partners are present on the governing board: elected members of regional authorities (region and departments) and representatives of producers and research and regulatory organizations. A technical team carries out actions in the field to support producers and their organizations. This novel partnership enables the various levels to act in permanent and organized accord. It contributes to efficient orientation of research and training efforts – upstream of development – and public policies of support for enterprises and professional organizations. This paper describes the structure and functioning of Cépralmar and illustrates its activity with concrete examples of regional lagoon aquaculture development.

Key words: *France, aquaculture, fisheries, lagoon, Région Languedoc-Roussillon, shellfish culture*

Introduction

Within the framework of the 1982 decentralizing laws, the 22 French regions were put in charge of the economic development of fisheries and aquaculture. Central government thereby delegated to the regions responsibility for implementing public policies in favour of those fields of activity. These policies should integrate all the needs of those industries – supporting investment in production, organizing markets, etc. – and also in the pre-production stages, vocational training and applied research.

The French Mediterranean coasts comprise three administrative regions: the Provence-Alpes-Côte D’azur region, the Corse region and the Languedoc-Roussillon region. The latter region is the most important for fisheries and aquaculture activities. These sectors play a considerable part in the economy of the region and constitute an essential link in its maritime heritage. In order to carry out these development missions successfully, the region has chosen to associate all partners of these sectors in devising regional policy. To this end a specific organization was created – Cépralmar (Anonymous, 2004).

Aquaculture and Fisheries in Languedoc-Roussillon

The geomorphological characteristics of the Languedoc-Roussillon littoral are particularly favourable for the fisheries and aquacultural activities that have developed there since ancient times (Table 1).

TABLE 1
Key fisheries and aquaculture data in Languedoc-Roussillon in 2003

Type	Number of enterprises	Production (tonnes/year)	Turnover (€million/year)	Jobs
Fisheries	1 100	35 000	120	2300
Lagoon fisheries	500	8 000	14	500
Sea fisheries	600	27 000	106	1 800
Aquaculture	700	20 000	26	2 000
Lagoon shellfish farming	650	16 000	20	1 750
Marine shellfish farming	40	4 000	3	200
New aquaculture ⁷	10	250 (+ alevins, spats)	3	50
Total	1 800	55 250	146	4 300

The Languedoc-Roussillon littoral comprises 220 km of coastline from the Spanish border to the Rhône River. About ten rivers, of which the largest is the Rhône, bring freshwater and nutritive elements. In the open sea, a wide continental shelf with an area of about 100 000 ha and an average depth of 40 m constitutes the Gulf of Lion. It is exploited by fisheries (trawlers, tuna boats, small scale fisheries) and shellfish farms.

The French Mediterranean lagoons have a total area of 57 000 ha in the three regions. In the Languedoc-Roussillon region, 28 000 ha of lagoons are exploited and constitute environments of exceptional trophic quality for the development of numerous species of molluscs, crustaceans and euryhaline fish (notably eels). The fisheries and aquaculture activities in the Languedoc-Roussillon lagoons represent about 24 000 tonnes of production, M€34 of annual turnover and 2 250 jobs.

Cépralmar, a Consultation Tool for Players in Fisheries and Aquaculture

Status and missions

Cépralmar is an association (non-governmental organization) that was created in 1981 by the elected members of the Regional Council, who wished to construct a consultation and technical assistance tool for professionals in maritime industries.

The statutory purposes of the organization are, *inter alia*, to:

⁷ Hatcheries, finfish and crustacean farming

- favour and promote actions aiming to safeguard fisheries and aquaculture, at sea and in lagoons and ponds, and to encourage efforts led by professionals to improve exploitation of the lagoon and marine environments; and
- contribute to defining a long-term policy for enhancing the coastal environment of the region.

Cépralmar defines and proposes to the Region strategic areas and concrete measures to build its fisheries and aquaculture policy. Thanks to its technical resources, it also assists the professionals of the sector in the field in carrying out their development projects.

Structure

The Governing Board of Cépralmar, which is elected for six years (following the same calendar as the Regional Council), groups together all the players engaged in domains to do with regional fisheries and aquaculture.

The 58 Administrators of Cépralmar are deployed in four colleges:

- College of Politically Elected Representatives: 24 members
 - 16 regional councilors (elected representatives of the Languedoc-Roussillon Region)
 - eight county councilors (elected representatives of the four coastal departments of the Region)
- College of Professional Representatives: 24 members
 - 12 professional fisheries representatives (from Prud'homies⁸, Local Fisheries Committee, Producers Organizations, etc.)
 - 12 professional aquaculture representatives (from Regional Shellfish Farming Mediterranean Section, Producers Syndicates and Organizations, etc.)
- College of Economic and Social Council: six members
- College of Key persons and Administrations: four members
 - one representative of research organizations (Director of IFREMER⁹)
 - one representative of training organizations
 - one State representative (Regional Director of Maritime Affairs)
 - one representative of the banking sector.

Means and methods of functioning

The governing board constitutes an arena of exchange and dialogue in which a policy promoting the fisheries and aquaculture of the Languedoc-Roussillon is built in a pragmatic fashion. The administrators of Cépralmar put forward proposals for programmes of action, applied research, studies or projects. They give opinions on all dossiers and applications for grants made to the Region. On the basis of these proposals, widely debated with the producers, the Region then implements its policy (financial aid, standpoints, etc.). Associating all partners in organized and participatory consultation before the policy decision process allows public policy to be directed as closely as possible to the needs of the sector.

⁸ Local organization of fishermen, specific to the French Mediterranean sea, in charge of fishing regulations and professional police

⁹ Institut français de recherche pour l'exploitation de la mer

The actions of the governing board are transmitted to the field by a technical team composed of scientists specializing in fisheries, aquaculture and coastal zone management. The team assists the professionals in their development projects (modernization of techniques, production tools, or marketing and processing facilities, etc.). Its proximity to producers enables it to inventory needs, encourage initiatives, and accompany and evaluate projects. The technical team also assists the representative professional organizations in carrying out their missions. Finally, it intervenes with players involved in the integrated management of lagoon and marine environments, so that the constraints and interests of fisheries and aquaculture are best taken into account. A part of the personnel working for Cépralmar consists of regional government officials involved in conducting the administrative and financial investigation phases of projects supported by the Region. Involving administrators right from the preliminary phase of consultation, and throughout the preparation and follow-up of projects, guarantees greater regional policy efficiency.

Organization of the Partnership

Promoting the acquisition and sharing of knowledge

The building of a common knowledge base is an essential stage in the consulting process. Decisions about managing activities should be based on reliable diagnoses and shared by all the players involved. The Cépralmar team collects and organizes information not only about fisheries and aquaculture but also the natural environments in which they take place. The fields of investigation concern technological (new products, production techniques, etc.), economic (knowledge of the enterprises, markets, etc.) and environmental (quality of lagoon and maritime environment) information. It contributes to defining and implementing programmes of applied research, follow-up networks and one-off studies. Databases shared by the various users and data suppliers (administrations, professional organizations and scientific bodies) are developed for the continuous monitoring of fisheries and shellfish farming. Cépralmar pays particular attention to disseminating this information. Its federating role enables it to ensure that all the partners share the information gathered. Information is seen as a tool for clarifying reflection and decisions about integrated and sustainable management of the littoral and its activities.

The Lagoon Monitoring Network (RSL): an example of associating producers organizations with research on the quality of natural environments

Cépralmar runs the Lagoon Monitoring Network¹⁰, which is jointly financed by the Region and implemented by Ifremer. The main objective of this network is to monitor eutrophication indicators in the Languedoc-Roussillon lagoons every year.

Meetings as well as the collation and communication of the results are organized by Cépralmar, liaising with management structures and the users of each lagoon site. These exchanges enable fisheries and aquaculture professionals to learn about recent scientific data on the quality of the natural environments they exploit. In return they inform researchers about the observations they have made through their daily presence on the lagoons. The regular exchanges also enable scientific work to be orientated towards the particular problems of each site. Thus, in addition to the trophic parameters, specific monitoring of other parameters (toxic, biological, etc.) is implemented depending on the requests made by the managers and users. For example, in 2004, modeling the spreading of microbiological pollutants and toxic plankton was carried out on the largest shellfish farming lagoon of the

¹⁰ <http://rsl.cepralmar.com>

Region (Thau Lagoon, 7 500 ha, 15 000 tonnes/year of shellfish). The results enable sanitary production management to be adopted by the professional organizations and public authorities.

In addition to these actions, Cépralmar has taken responsibility for running the SYSCOLAG “Coastal and Lagoon Systems” research programme, which federates regional scientific capacities (Universities, CNRS¹¹, Ifremer, IRD¹², BRGM¹³, Cémagref¹⁴, etc.) around integrated and sustainable management of the littoral (lagoons and coastal strip). The principle objectives of the programme are to:

- propose relevant monitoring indicators for environments and practices;
- build scientific decision making tools; and
- define appropriate methodologies for sustainable management of the littoral.

The SYSCOLAG programme (2002/2006) articulates 11 doctoral dissertations that are being written in various disciplines (fisheries, economics, sociology, geology, geography, information technology, etc.). These dissertations, financed by the Region, are being prepared in parallel; regular workshops allow interdisciplinary exchange and the sharing of scientific knowledge.

Encouraging innovation

Innovation is a driving force behind the creation of new wealth. Nevertheless, the link between research and production sectors is often difficult to establish. Working in close partnership with the regional and extra-regional research organizations, Cépralmar serves as an interface. It identifies needs and contributes to the elaboration of R&D programmes adapted to the fisheries and aquaculture sectors. Then it communicates the results of the programmes and transfers the new technologies to the professionals.

Diversifying lagoon production: an example of partnership between research and development bodies and professional organizations

Lagoon fisheries and shellfish farming are undermined by damage to the quality of the natural environment and by the decrease in certain resources. Diversifying the techniques or the species exploited can contribute to limiting the socio-economic impact of these problems. Cépralmar carries out pilot development projects in close cooperation with both professional and research bodies. These experiments, carried out on a production scale, are intended to demonstrate the technical and economic feasibility of new methods of production. The following examples can be cited from the period 2000-2004:

- a multidisciplinary programme, on the management of clam resources (*Ruditapes decussatus*);
- associating laboratories that research economics, sociology and fisheries;
- the release of shrimp (*Marsupenaeus japonicus*) postlarvae and extensive breeding in the Narbonne lagoons; and
- a programme diversifying shellfish farming techniques using triploid oyster spat (*Crassostrea gigas*) bred in hatcheries.

¹¹ Centre national de recherche scientifique

¹² Institut de recherche pour le développement

¹³ Bureau de recherche géologique et minière French

¹⁴ Centre de machinisme du génie rural, des eaux et des forêts

These operations are financed by public funds from the Region and the EU (FIG¹⁵). They generally use professional logistical resources (breeding beds, boats, etc.) and draw on their know-how and capacities. Research bodies participate closely in their implementation: designing monitoring procedures, providing advice and scientific opinions, assisting applied research programmes, etc. Involving professionals with the experiments ensures that techniques are rapidly spread horizontally, with the added bonus of reinforcing partnerships with research bodies.

Developing the production infrastructure

Cépralmar contributes to defining regional policy with a view to strengthening, both upstream and downstream, the environment in which the fisheries and aquaculture sectors of the Region take place. It proposes practical and varied measures in order to:

- manage lagoon and marine environments (e.g. anti-pollution measures, hydraulic equipment, immersion of artificial reefs);
- reinforce professional organizations (e.g. help with recruiting and action programmes);
- train professionals and support young people setting up businesses;
- adapt collective infrastructures (e.g. fishing ports, shellfish farming plots);
- modernize production structures (e.g. fishing boats, fish farms); and
- enhance the aquatic production of the Region (marketing and processing enterprises).

The regional public funds allocated – an average of €4 million/year – are subject to financial regulations, discussed with the professionals. Every grant-aided project – 300 per year on average – is systematically submitted to the opinion of the governing body of Cépralmar. Regional subsidies, often enlarged by European (FIG) funds, enable the necessary structural adaptations in these sectors to be set in motion and accelerated.

In recent years, for example, the following programmes have been carried out:

- implementing health standards and installing shellfish purifying equipment in shellfish farms on the Thau and Leucate lagoons;
- mechanizing product processing;
- equipping lagoon fleets with less polluting motors (4-stroke outboards);
- modernizing fishing fleets (new boats, equipment for processing catches on board); and
- implementing health standards in fish markets, etc.

Conclusions

Cépralmar is an example, on a regional scale, of the way in which all partners involved can be associated in defining public policy in favour of fisheries and aquaculture. The partnership and permanent exchanges have, in particular, enabled research work to be correctly orientated and the dissemination of its results improved, thereby favouring the best response to these needs of the sector.

The recognition of the specificity of Mediterranean fisheries – and in particular of lagoon fisheries – is still slower than desirable, as much on the part of central Government as on that of Europe in the framework of the Common Fisheries Policy (CFP). Although the concepts on which the actions of Cépralmar are based – knowledge sharing, consulting, participatory democracy – are today widely advocated at the various national and European policy levels,

¹⁵ Financial Instrument for Fisheries Guidance

the number, variety and distance – physical or cultural – of the players involved at these levels frequently hold back their application. The decision-making process with regard to fisheries and aquaculture regulations remains centralized. The ensuing constraints, notably on regional policy, are powerful and sometimes not adapted to the local context. National and European policies would, however, become more effective if they were based on greater consultation with professional organizations. Cépralmar could be an efficient regional tool for relaying the necessary consultation process.

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AQUACULTURE IN THE DANUBE DELTA DURING THE TRANSITION PERIOD

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ABSTRACT

The Danube delta is one of the largest wetland zones in Europe, included in the Danube Delta Biosphere Reserve (DDBR), and encompassing a surface area of 580 000 ha. Fish farming was introduced there in 1961, covered an area of 49 000 ha by 1989, and was considered a flourishing activity in the time of socialism. The ponds are very large (up to 1 000 ha) and are difficult to manage. The major cultured species are common carp, silver carp, bighead carp and grass carp. Final net production averages 68 ± 32 kg/ha/year in non-fed ponds and 269 ± 195 kg/ha/year in fed ponds, with additional harvests of 44 kg/ha and 69 kg/ha respectively of wild species. However, the fish farms, subsidized by the state in the past, are in economic difficulties, with production costs exceeding the value of production. This paper provides a rough analysis of costs and prices, in order to determine the minimum economically feasible production rate required. The major constraints in achieving those levels and the steps being taken to address them are reviewed.

Key words: *Romania, aquaculture, bird predation, Danube delta, economic transition, technology*

Introduction

The Danube delta, including the lagoon lake complex Razim-Sinoie, is geographically situated in the southeast of Romania, between parallel $44^{\circ}30'$ and $45^{\circ}30'$ northern latitude and meridian $28^{\circ}40'$ and $29^{\circ}50'$ eastern longitude (Figure 1). In 1990, Romanian Government Law declared this territory the Danube Delta Biosphere Reserve (DDBR) and this status was recognized through a special law in 1993. The ecological significance of the area was also recognized when it became a Ramsar Convention and World Heritage Site. Harmonizing actions for the economic development of the Danube delta and the conservation of its natural attributes represent a fundamental objective, emanating from the MAB-UNESCO Programme concept. The Danube delta suffered a lot of hydrological changes over time. During 1903-1960 (the so-called "fisheries period") several canals were built and enlarged for improving water circulation to increase fish yield. Between 1960 and 1970 (the "reed period") intense hydro-technical works were made for reed harvesting and increasing transport. In the period from 1970 to 1980 (the "cultured fish period") large areas of wetland surface were enclosed for fish ponds. Finally, in the period 1980 to 1990 (the "agricultural period") more immense surface areas were enclosed by poldering and drained for agriculture.

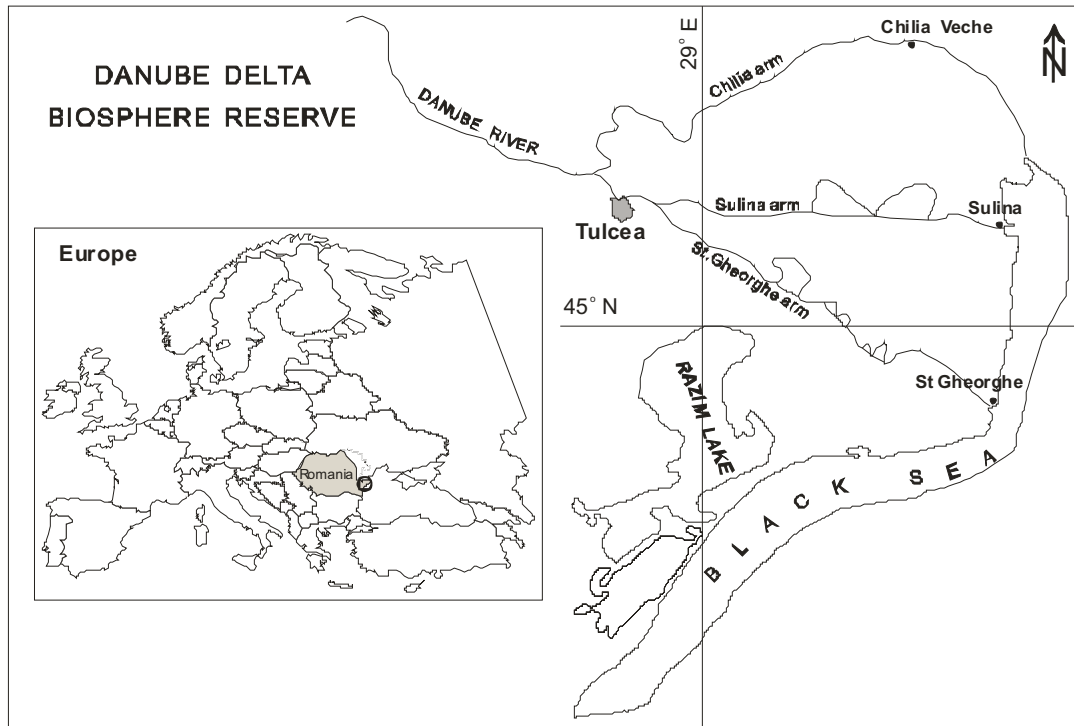
The 1975 Fishery Development Programme

The Fishery Development Programme of 1975 targeted an increase in Danube delta inland fisheries production of 262 percent in the five years to 1980 and another 73 percent within the following decade. At first results were very promising; the embankment of only 9.4 percent of the delta surface generated 50 percent of the total fish production of the area. This significant result supported the further development of fish culture ponds by this process (Gheracopol, 1979). The programme indicated that the embanked surface for fish ponds should reach up to 111 000 ha by 1980 (Pojoga, 1977). The reason for the introduction of fish farming in the Danube delta was to replace the production lost from the Danube River flood plain that had

been poldered for agriculture, and also to increase fish production for food consumption. In recent years the fish farming activity in this area has been criticized for poor yields and economic results.

The present study analyses the status of fish culture and its future in the DDBR (Figure 1) concerning technical, economic, and environmental limiting factors, using aquaculture statistical data and construction design parameters.

FIGURE 1
The location of the Danube Delta Biosphere Reserve



Results

Development of fish farming

Fish farming was introduced into the Danube delta in 1961, with the first farm covering an area of 560 ha. A major expansion of fish farming took place in the period between 1969 and 1974, by which time the total farmed area had increased to 30 000 ha; by 1990 it had expanded further to approximately 49 000 ha.

Danube delta fish farming faces the following difficulties:

- extra large ponds of up to 1 000 ha (difficult to control);
- shallow water depth (facilitating predation by birds);
- high organic content of dikes (causing losses of water through seepage); and
- the necessity to pump water (expensive energy costs).

Fish species cultured

The main species cultured are:

- common carp (*Cyprinus carpio*);
- silver carp (*Hypophthalmichthys molitrix*);
- bighead carp (*Hypophthalmichthys nobilis*);

- grass carp (*Ctenopharyngodon idella*); and
- black carp (*Mylopharyngodon piceus*).

Common carp is a naturalized species, introduced before the year 1300, while the other four species are Chinese carps that have been introduced into Romanian ponds since 1962 (Manea, 1985).

Small-scale production of pike (*Esox lucius*) was achieved and pike-perch (zander) eggs (*Stizostedion lucioperca*) are still being produced for stocking. Both artificial and natural-controlled spawning were achieved for wels (*Silurus glanis*), in a research project. Three species of buffalo fish (*Ictiobus bubalus*, *I. cyprinellus* and *I. niger*) were introduced into aquaculture but after several years of difficulties this activity was abandoned.

Natural pond productivity

The natural productivity potential, calculated through the Léger-Huet method (Arrignon, 1968), ranged between 100-300 kg/ha in delta fish farms, some of which are detailed in Table 1. The natural productivity for planktivores (Chinese carps) is up to 700 kg/ha, due to the eutrophic nature of ponds.

TABLE 1
The natural productivity potential (Pn) of some Danube delta fish ponds, estimated through the Léger-Huet method

Pond surface (ha)	Depth (m)	Pn (kg/ha)	Farming system
2400	2.5	172.5	extensive
2062	1.5	195.8	extensive
4	0.7	179.9	intensive
7	1.2	159.9	intensive
500	0.7	213.2	extensive

Source: Arrignon (1968)

Fish culture technology

The Chinese carps are artificially reproduced with pituitary gland material (2-4 mg/kg body weight) using Chinese spawning and incubation techniques. One million 3-5 day-old larvae are obtained from four males and eight females for common carp and eight males and 12 females for Chinese carp. Incubation is conducted in five litre or 50 litre Zug-Weiss and/or Nucet box incubators (Pojoga, 1977). Fish larvae are nursed until they weigh 0.25 g (fry) in 0.5 ha Dubisch ponds or in the drainage channels of first summer rearing ponds. A density of four million larvae/ha is used and the survival rate at 14-20 days is 25-30 percent.

The fish are reared in a two to three year cycle, the first year to produce stocking material and the second/third years for grow-out under monoculture and/or polyculture systems with or without feeding (Table 2). Fish are generally fed with commercial feeds with formulae (Table 3) that are specific for the various developmental stages of the fish and the farming system. However, fish have often been fed with single feed ingredients alone, such as maize or barley. In polyculture, there are many stocking regimes with common carp (1+ and 2+) and Chinese carp (1+ and 2+), for different areas and technologies.

TABLE 2
Technology of fish farming in the Danube delta

Farming system	Ponds area (ha)	Fish weight (g)	Stocking density ('000/ha)	Growth (g)	Survival (%)	Yield (tonnes/ha)
FIRST YEAR						
<i>Monoculture</i>						
Common carp	5-150	0.1-1	75-120	40-50	25-40	1.2-1.8
<i>Polyculture – fed</i>						
Common carp	5-150	0.1-1	43-71	35-40	30-35	0.6-0.7
Chinese carp	5-150	0.1-1	83-107	20	30-35	0.6-0.7
<i>Polyculture – non-fed</i>						
Common carp	>30	0.1-1	2	35	30	0.02
Chinese carp	>30	0.1-1	98	20	35	0.68
SECOND/THIRD YEAR						
<i>Monoculture</i>						
Common carp	150-500	30-250	4-7	250-900	40-80	1.0
<i>Polyculture – fed</i>						
Common carp	100-600	40-250	0.6-6	200-800	40-70	0.5-0.9
Chinese carp	100-600	20-250	0.7-5.3	150-1 200	40-80	0.5-0.9
<i>Polyculture – non-fed</i>						
Common carp	>3 000	250	0.2-0.3	500-750	50-70	0.1
Chinese carp	>3 000	250	0.5-0.8	300-1 100	50-80	0.4

TABLE 3
Typical feed formulations used in the Danube delta fish farms (%)

Formulae	I	II	III	IV	V
Age of fish	4-15 days	16-40 days	41-160 days	2nd year	3rd year
Fish meal	30	18	3		
Meat meal	12	12	3		
Soybean extractions	20	28	33		
Wheat meal	19	21	20		
Fodder dregs	8	6		5	5
Powdered milk	8				
Edible oil	2				
Vitamin/mineral premix	1	1	1		
Maize meal		14	14	35	30
Sunflower extractions			8		
Barley meal			13		
Chalk			5		
Edible residue extract				50	50
Chicken offal				10	10
Poultry excreta					5

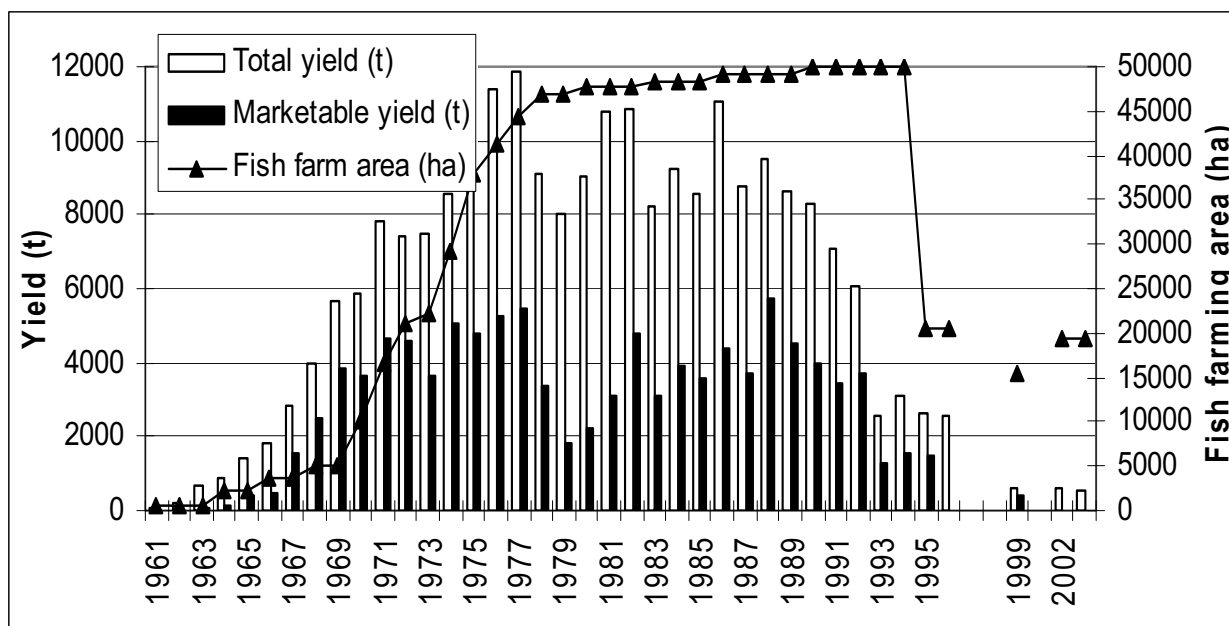
These technologies were imposed by the controlled economy but, generally, it was impossible to apply them properly due to shortages in stocking material or suitable feed supplies.

Fish farming results

The total production from fish farms has increased over time but not as much as would be expected from the expanded fish pond areas developed. In spite of increasing fish culture pond surface and total yields, the marketable fish¹⁶ production remained relatively constant at 4 000-5 000 tonnes/year (Figure 2). Unit productivity increased in accordance with increasing fish farming area from 1961 to 1969 (Figure 3); after that, farming efficiency decreased sharply. The highest productivity, close to target, was reached in 1963 and 1969 (1 000-1 200 kg/ha). After 1977, productivity decreased to 200 kg/ha, while marketable productivity declined to only 100 kg/ ha.

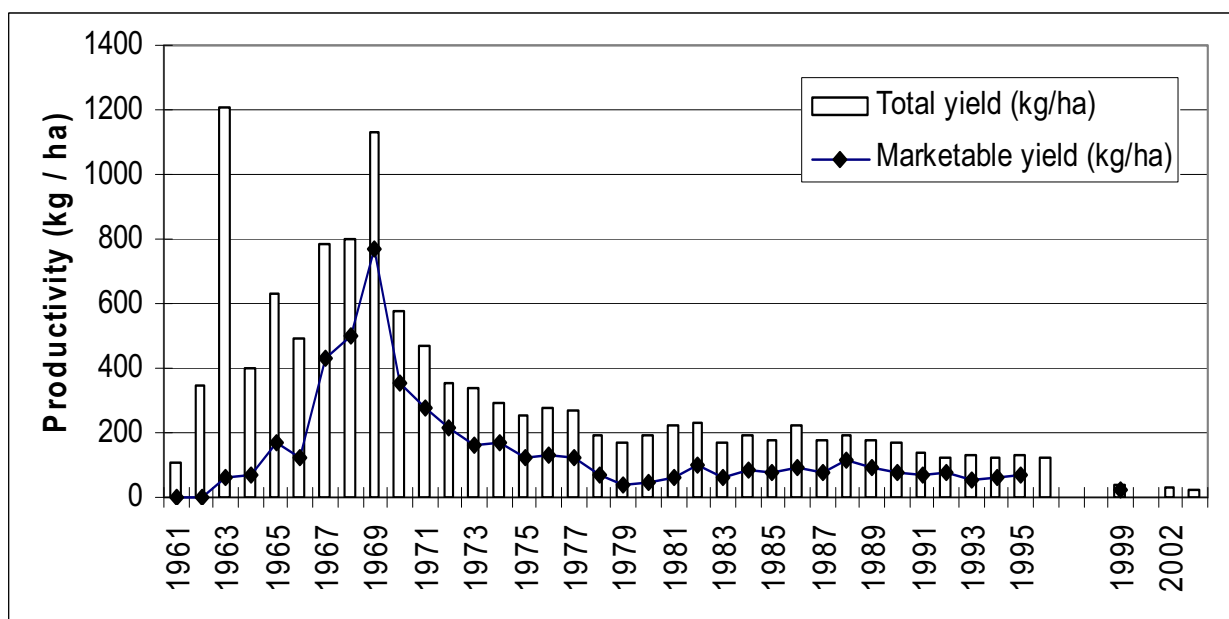
¹⁶ The difference between total and marketable fish production consists of breeders and juveniles

FIGURE 2
Evolution of fish farming development and yield results



Note: for the period 1994-2003, only used farming area is included

FIGURE 3
Productivity dynamics of total and marketable yields in fish farms



Note: for period 1994-2003, only used farming area is included

After the end of the planned socialist economy (1989), fish farming collapsed in the Danube delta during the transition time to a market economy. Some fish farms or ponds were no longer used for aquaculture, being abandoned or used for alternative purposes such as agriculture, hunting or sport fishing. By the beginning of the current decade, less than half of the fishing capacity area is used for aquaculture, producing only around 600 tonnes total yield

(370 tonnes for marketing). Fish farm productivity collapsed to 40 kg/ha, from which 24 kg/ha of marketable yield was recorded. This means that productivity fell to less than the capture fish productivity of the surrounding natural waters.

The situation differs slightly between fed (Table 4) and non-fed rearing systems (Table 5), but both obtained poor results. Wild fish species represented 8-33 percent of the total yield in fed farms and 12-60 percent in non-fed farms. In most cases the wild species were deliberately introduced into ponds when they were filled, through monks or pumping, especially in recent times.

TABLE 4
Some results from fed fish farms in the Danube delta

Farm No.	Farm area (ha)	Stocking rate (kg/ha)	Total yield (kg/ha)	Contribution of wild species to total yield (kg/ha)	Total growth (kg/ha)	Feed supply (kg/ha)	Period
1	2 230	79	188	35	109	384	1976-1989
2	720	91	221	2	130	302	1986-1989
3	420	69	225	21	156	302	1981-1989
4	1 651	220	880	75	660	1 692	1975-1989
5	2 500	108	238	56	130	406	1975-1987
6	700	130	382	102	252	208	1986-1989
7	1 070	98	332	109	234	600	1977-1989
8	1 350	195	526	41	331	984	1975-1989
9	6 400	52	126	28	74	333	1981-1989
10	2 580	86	201	62	115	156	1978-1989
11	590	329	906	126	577	1 533	1981-1989
12	1 344	194	434	109	240	808	1975-1989
13	1 050	144	300	49	156	442	1975-1989
14	240	228	946	96	718	1 662	1975-1989
15	331	196	586	152	390	761	1977-1989
16	452	313	410	41	97	257	1984-1989
17	1 477	158	431	69	269	677	1975-1989
18	1 467	82	260	41	195	509	1975-1989

TABLE 5
Some results from non-fed fish farms in the Danube delta

Farm No	Farm area (ha)	Stocking density (kg/ha)	Total yield (kg/ha)	Contribution of wild species to total yield (kg/ha)	Total growth (kg/ha)	Period
1	1 800	81	232	70	151	1972-1989
2	2 980	12	40	24	28	1970-1981
3	2 900	20	64	8	44	1974-1982
4	2 270	30	77	31	47	1979-1989
5	1 505	79	133	65	54	1984-1989
6	2 835	51	128	56	77	1984-1989
7	1 270	41	119	63	78	1979-1989
8	2 683	48	126	36	78	1971-1981
9	1 709	40	92	41	52	1984-1989
10	2 217	45	112	44	68	1971-1989
11	590	21	49	19	32	1970-1989

Generally, the production of Danube delta fish farms was below the planned level. An economic study revealed that only one out of six farms in 1985 had a positive result. During production it was necessary to spend US\$5 to earn US\$1 in revenue; the economic losses were covered by state subsidies.

In 1993, 30 fish farms (45 521 ha) in the Danube delta, from which 39 627 ha were under the administration of the local county (of which 9 230 ha were abandoned), were included in a programme for ecological reconstruction by the DDBR. This programme proposed to reconstruct up to 60 260 ha of ponds and polders.

In the transition period, an adaptive technology based on maintaining costs at the level of marginal profit, without an obligatory plan of production, was tried by farmers. The minimal technology involved implied partial water pumping, minimal stocking, less or no feed and traditional fishing to lower production costs (Tables 6a and 6b).

Production costs increased, compared to 1994, following the open market policy of the country and globalization. However, the value of fish farm products, which are sold exclusively in the national market (where consumers do not place a high value on fish), did not increase accordingly.

TABLE 6A
Fish farm study case for farming activity in Danube delta area in 1994

Total area (ha)	Used area (ha)	Total yield (kg)	Productivity (kg/ha)	Market yield (kg)	Market yield productivity (kg/ha)	Juveniles and breeders (kg/ha)
549	456 (83%)	210 100	460.74	134 500	294.96	165.78

TABLE 6B
Cost structure for production of 1 kg fish

Item	%
Labour, tax and interest	34.03
Stocking material	11.53
Feed	10.64
Electric power	12.84
Other materials	4.13
Overheads	14.56
Profit	12.27
Total	100.00

Impact of birds

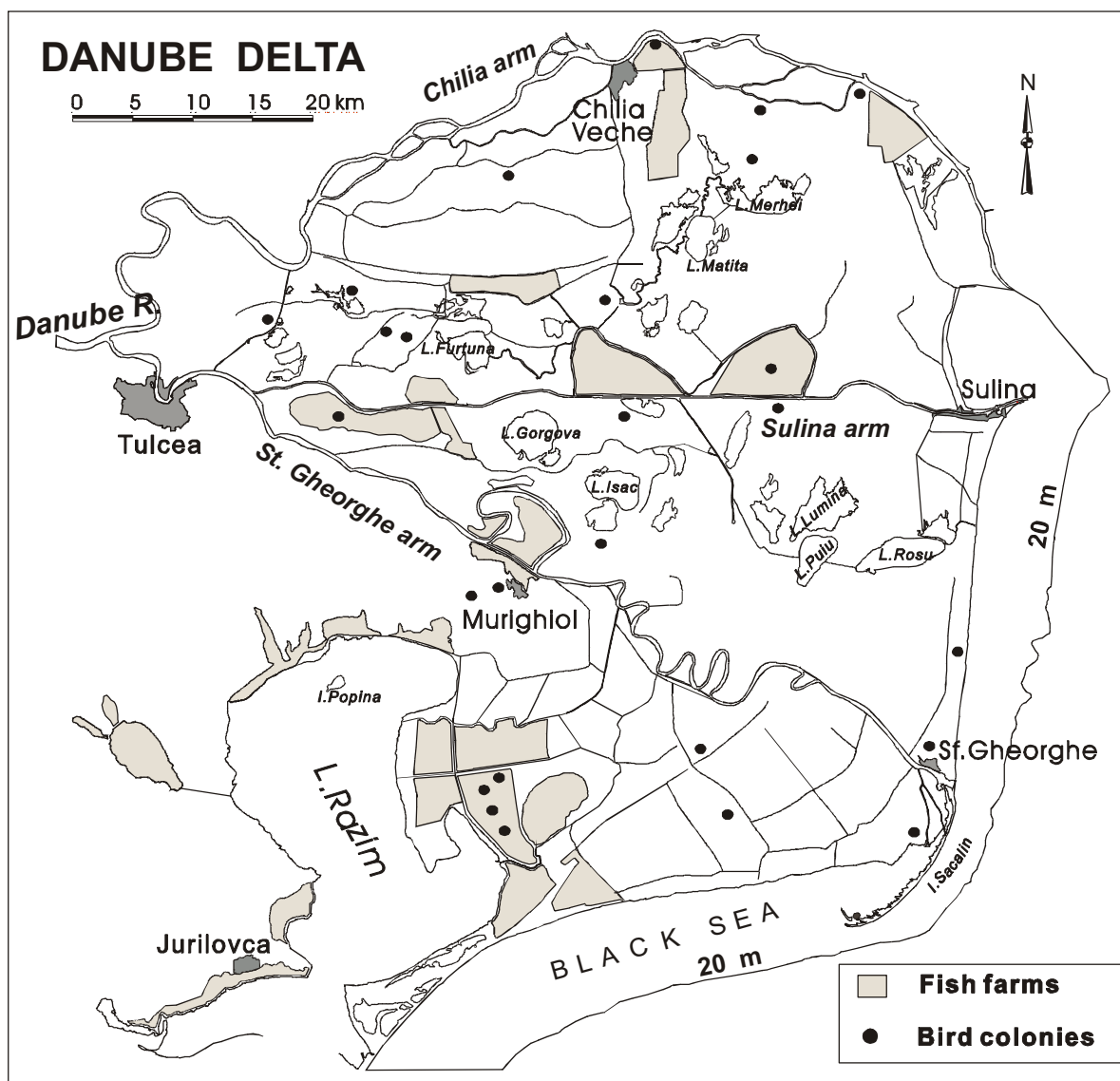
The Danube delta is a large wetland zone, with important habitats for local and migratory bird species. Most of them are ichthyophagous and prefer to eat young fish, which are more vulnerable in fish ponds than the wild fish species in natural waters (Figure 4). The protected status of birds and the location of farms within and in the neighbourhood of bird colonies cause the greatest loss of fish, especially in stocking material (Table 7).

Impact of the free market economy

The free market economy has created many problems for fish farmers. The demand for Chinese carps, which are farmed without feed, decreased. These species took the place of common carp in the yield structure, rising from 29 percent in 1969 to 50 percent in 1989. Recently, the demand for Chinese carp has decreased dramatically, resulting in lower prices than those attained by common carp.

Marine fish, imported at lower prices, are preferred by fish processors due to the ease of processing. They are also an alternative in the consumer market, to the detriment of cultured fish. Freshwater wild species, with low fishing costs, also compete with cultured fish.

FIGURE 4
Distribution of fish farms and bird colonies in the Danube delta area



The costs of fuel and electricity used for pumping water and other activities has reached international levels but the economic basis of fish farms was designed around the cost of state-subsidized energy costs. The result was an increase in total production costs. A rough calculation of production costs indicates that fish farms can be profitable at productivity levels of 100 kg/ha or more for non-fed systems or 500 kg/ha or more for fed systems with minimal technology application (Staras, 1994).

Discussion

Fish farming in the Danube delta was developed under the controlled economy in order to produce food and replace the loss of fisheries production from the impoundment of the Lower Danube River flood plain for agriculture. The results and efficiency reported were doubtful, even in a directed economy with subsidized production costs and imposed technology.

TABLE 7

Calculation of yearly fish consumption by piscivorous birds in the Danube delta

Species of birds	Days present in Delta	Birds* (No.)	Ration** (kg/day)	Total (tonnes/year)	Fish (g)
<i>Pelicanus o. onocrotalus</i>	230	5 000	1.6	1 840	10-1 260
<i>Phalacrocorax c. sinensis</i>	245	25 000	0.75	4 594	1.3-700
<i>Phalacrocorax pygmaeus</i>	200	9 125	0.3	548	7.3-71
<i>Ardea cinera cinera</i>	275	775	0.5	106	1-125
<i>Ardea p. purpurea</i>	175	350	0.15	9	1-102
<i>Ardeola ralloides</i>	165	5 750	0.05	47	1-10
<i>Egretta garzetta garzetta</i>	175	3 500	0.1	61	0.3-14.6
<i>Nycticorax n. nycticorax</i>	215	6 750	0.14	203	1-10
Total				7 408	

* adult birds (Marinov, 1995; Marinov and Hulea, 1997)

** fish consumption by birds (Andone *et al.*, 1969)

The main constraints of farming in this zone are the existence of large ponds that are uncontrollable from a technological point of view; a substantial impact of piscivorous birds; and the impact of the free market economy. Intensive fish farming can be applied only in certain cases in the best farms or ponds. As an alternative, fish farming can survive in the Danube delta as an extensive system with a net productivity at least 100 kg/ha in non-fed farms and at least 500 kg/ha in fed farms. However, it would be advisable to return unsuitable ponds to the natural regime to provide natural spawning areas and increase wild fish stocks.

To survive in the market economy, the delta farms have developed a mixture of activities, such as fish culture, sport/recreational fishing, hunting and agriculture. In addition, most of the fish stocked arise from trapping wild fish through river water intake. Privatization has solved some aspects of efficiency and management in an open market economy without state subsidies but cannot eliminate the constraining technological and natural factors for fish culture.

The policy of the DDBR Authority is to return non-productive polders and ponds to nature. The first step is to restore about 15 000 ha, from which 9 230 ha of ponds were connected to the natural hydrological system; the final aim is to restore 60 260 ha to natural conditions.

Furthermore, it is necessary to carry out a technical and economic analysis of each pond to advise the most suitable land use, and to make policy decisions for change, where required.

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ENHANCED STAKEHOLDER INVOLVEMENT AS A TOOL FOR FURTHER DEVELOPMENT OF THE DUTCH AQUACULTURE INDUSTRY

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ABSTRACT

Commercial finfish farming in the Netherlands is a young and rapidly developing industry, which produced approximately 10 000 tonnes in 2003. The industry is almost entirely based on recirculation technology, which makes it possible to farm fish independently of the location. As a result, farms producing the same species can be found in very different locations with different local policies and regulations. A recent study concluded that enhanced stakeholder involvement would be instrumental for the further development of the industry. This paper describes the present stakeholder involvement and recommended future models. It also includes examples of stakeholder involvement used in the design of future aquaculture systems, and consumers perception of farmed fish and fish welfare.

Key words: *Netherlands, aquaculture, platform, recirculation, stakeholder*

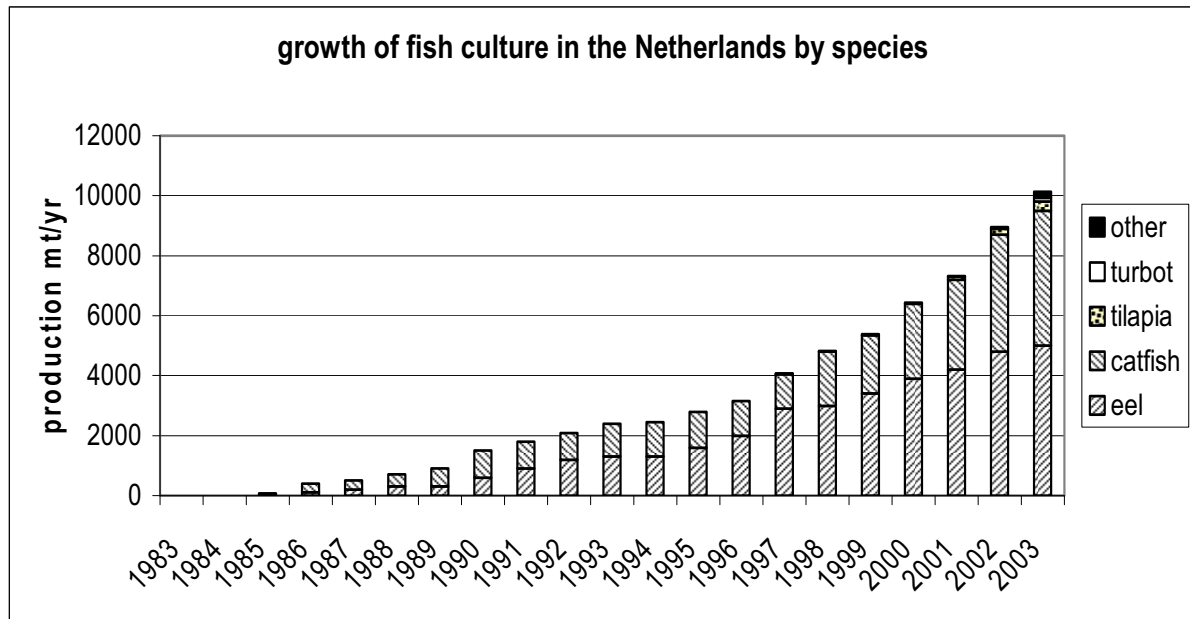
Introduction

Dutch fish farming developed in the early 1990s into a professional industry. Since then total finfish production has grown to approximately 10 000 tonnes (Figure 1), corresponding with an annual growth rate of 14 percent. Eels and African catfish are the major species, constituting over 90 percent of the total production (Table 1). Farms producing other species such as tilapia and turbot have recently started operations. Of the total European eel and catfish production, 60 percent and 90 percent respectively are produced in the Netherlands. Although the industry is growing quickly, farmed fish contributes not more than eight percent of the total fish and shrimp supply at Dutch fish auctions, and less than one percent of the total European aquaculture output of these product groups.

Despite being small, the Dutch fish farming industry has specific characteristics that make it unique. For species traditionally grown in West and Central Europe (such as carps) no market exists in the Netherlands. Furthermore, the climatic circumstances in the Netherlands are not favourable for the culture of common warmwater species (such as seabass or seabream) or coldwater species (e.g. trout, salmon) in open systems. Therefore, the industry started growing only when reliable systems became available that allowed full control over water temperature and quality, without excessive energy costs.

Nowadays more than 95 percent of the total farmed finfish supply in the Netherlands is produced in recirculation systems. Many disadvantages of commercial fish culture in open systems that affect the environment do not appear (or appear to a much lesser extent) in recirculation fish culture. Another consequence of this development is that farm location no longer depends on access to open waters. Therefore, fish farms are situated in very differing locations. In the countryside, fish farms are often situated at former pig or poultry farms. Fish farms can also be found in inland or coastal industrial parks. This implies that a wide range of local authorities are confronted with fish farming and matters related to farm licences, waste water treatment, etc.

FIGURE 1
Development of finfish culture production in the Netherlands



Source: LNV (2004)

TABLE 1
Estimated production of fish culture in the Netherlands in 2003

Species	Production (tonnes)
Eels (<i>Anguilla anguilla</i>)	5 000
Catfish (<i>Clarias gariepinus</i>)	4 500
Tilapia (<i>Oreochromis niloticus</i> & <i>O. mossambicus</i>)	300
Turbot (<i>Psetta maxima</i>)	130
Other species	200
Total	10 130

Source: LNV (2004)

Another important point is that the investment costs for recirculation fish culture are relatively high. In a competitive international environment, continuing intensification of production is essential for many farmers in order to survive. This may have consequences for fish welfare and it makes the industry vulnerable to criticism from consumers and NGOs that proclaim intensive fish farming as a new form of “bioindustry”.

It has been concluded (van Zwieten, 1998) that large-scale fish farming is not really getting off the ground in the Netherlands due to inadequate knowledge and lack of cooperation between partners in the food industry, combined with relatively laborious relations between industry and knowledge institutes. Since the farming sector is quite small, the basis for supporting strategic scientific research and development studies is also small.

It can thus be concluded that Dutch finfish culture is small but, due to the nature of the industry, is being influenced by a large number of different stakeholders.

Stakeholder Involvement

The traditional means of stakeholder involvement consist of quarterly meetings between the organized producers, the national fish board and the central government (Department of Fisheries of the Ministry of LNV). These parties jointly organized a symposium on the future perspectives for fish culture in the Netherlands, which in turn contributed to the formulation of policy guidelines (LNV, 2004). During this process it was realized that enhanced participation and consultation of a broader group of stakeholders could contribute to the further development of sustainable aquaculture. Recently a number of initiatives to enhance stakeholder participation have been undertaken.

Project Ocean Farming

The purpose of this project was to explore future possibilities for the sustainable exploitation of marine organisms. Initiated and coordinated by the Netherlands Study Centre for Technology Trends (STT) a series of meetings, in which 50 to 70 external experts from private companies, research institutes, government and societal organizations participated, took place between September 2001 and late 2003. Divided into three design groups (the North Sea, an estuarine area, and land-based aquaculture) the participants developed a future vision of a sustainable exploitation of marine organisms for that specific area. Recently this project was concluded with a publication by Luiten (2004) in which a number of innovative concepts for fishery and aquaculture have been developed, as well as a number of policy recommendations.

LNV Consumer Platform

In order to understand the trends in the perception and attitudes of consumers towards agricultural products (including fish) better the Ministry of LNV regularly organizes consumer platforms. Each platform consists of approximately 20 persons that have a certain affinity with food and consumer trends. In March 2003 “fish” was the subject of the platform. Firstly, fish facts, policies, trends and opinions were summarized in a desk study report (LNV, 2003). This formed the basis for representative consumer research and for discussions with three consumer panels – customers at the fish market; owners and employees of fish shops; and the wives of fishermen. Finally the Consumer Platform met and concluded that:

- product information on fish is incomplete or incorrect (e.g. frozen fish being sold as fresh fish);
- new “animal-friendly” methods have to be developed for killing fish; and
- adequate legislation for the use of veterinary products in fish farming has to be developed.

Based on these conclusions a number of policy decisions were taken by the Ministry.

The views of citizens on fish farming

Technological and scientific developments often generate more social and political questions than answers. To stimulate both research and discussion, the Rathenau Institute enables politicians and citizens to judge issues that are linked to these developments. This institute is an independent organization established and financed by the Dutch Ministry of Education, Culture and Science. In 2003, the institute organized a citizens’ panel about livestock farming (including fish farming) with the aim of gaining a better insight into what citizens consider a minimum standard for animal welfare. Firstly a group of approximately ten citizens visited two fish farms. Subsequently, the observations of the group were tested in a broader study with *ca.* 500 representative respondents. Verhue and Verzijden (2003) concluded that the majority of the citizens had a rather positive opinion about fish culture. However, citizens

were critical of the current slaughtering methods for farmed fish, as well as towards the available space in the culture tanks. Once more scientific information regarding fish welfare becomes available the opinion of citizens could change. Therefore it is important that the fish farming industry remains transparent and open towards society.

Innovation Platform Aquaculture

In December 2003 the Minister of LNV inaugurated a platform with the responsibility of stimulating innovations in aquaculture so as to contribute to the sustainable development of the aquaculture industry in the Netherlands. The platform consists of representatives of the primary producers, supporting industry, research organizations, and regional and central governmental agencies. An ex-member of Parliament meets the interests of the general public, and an innovation advisor supports the platform. The specific tasks of the platform are the:

- identification of the most feasible opportunities for aquaculture development in the Netherlands;
- formulation of a national aquaculture research agenda;
- identification of bottlenecks in policy and legislation;
- stimulation of cooperation within the industry and between the industry and opponent groups; and
- facilitation, with the establishment of a number of innovative aquaculture projects.

The Ministry is supporting the platform financially for an initial period of two years. Thereafter, a growing share of the required funds will have to be provided by the industry. At present the platform is working on the identification of opportunities, for which a number of workshops with concerned stakeholders will be organized.

Conclusions

The aforementioned examples of stakeholder participation not only yielded policy recommendations but, more importantly, opened a dialogue between stakeholders on the topic “aquaculture”. It is clear that different stakeholders have different interests but, at the same time, it can be concluded that having this dialogue provides better opportunities for the development of a sustainable industry. In the Netherlands, it is expected that the Innovation Platform Aquaculture will continue to play a leading role in this process.

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ACCELERATING THE SCIENTIFIC AND TECHNICAL DEVELOPMENT OF COMMERCIAL AQUACULTURE IN THE RUSSIAN FEDERATION

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ABSTRACT

By 2004, the new economic policy in Russia was more than ten years old and had touched all industries of the national economy of the Russian Federation, including aquaculture. This paper reviews the methods used in accelerating the scientific and technical development of commercial aquaculture in Russia. The paper continues by discussing the financial, scientific, and technological problems faced during this period. Finally, the role of the "research and production centres" that were established in 1995 in solving these problems is described.

Key words: *Russian Federation, aquaculture, commercial, economic effects, policy, productivity, risks, scientific and technical methods*

Introduction

Progress in development is determined by qualitative achievements in the scientific-technical sphere. The specific characteristics of every business define the way in which these achievements influence their commercial-technological and social-economic status.

Aquaculture, being a progressive direction of the fish industry, is determined by two mutually dependent factors – the products are living organisms and require a suitable environmental habitat for survival. The basis of scientific-technical development, both for individual enterprises and for the fish industry as a whole, is a comprehensive study of the biology of the organism to be reared and the definition of the optimal conditions for doing so.

Historical Background

Since the 1950s there have been several periods of accelerated development in aquaculture in the Russian Federation. These were related to the wide-ranging use of scientific-technical developments. Firstly, a range of herbivorous fish species, mainly silver carp (*Hypophthalmichthys molitrix*) was introduced into pond culture. This helped to raise productivity by a considerable factor, without the use of artificial feeds. Now herbivorous fish represent 45-50 percent of the total volume of marketable fish production from aquaculture in Russia. Secondly, commercial aquaculture was established independently, whereby thermally enriched water from power stations is used. The production of marketable farmed fish from thermally enriched waters had risen to 30 000 tonnes/year by 2003. In both cases good results were obtained due to a combination of research work and its application at specially-prepared farms.

Scientific and technical advances in the aquaculture sector have a multifunctional character and are based on two very important factors:

- the level of scientific and technological developments of scientific organizations; and
- the basic material, technical and structural conditions of commercial enterprises.

Weakness in either of these can have deleterious effects on both the scientific and technical development of the specific enterprise and on the aquaculture sector as a whole.

Science started to become an important mover in aquaculture development in Russia at the beginning of the 1960s. During this period there was a movement from extensive towards intensive aquaculture; this was characterized by effective developments in the fields of fish feeding, pond fertilization and a broadening in the diversity of the species being reared. This was also the beginning of an ecosystem method of using the natural feed resources of water-bodies in all links of the trophic chain. These developments were the result of basic and applied research. The result of these research activities and those of commercial aquaculture farms was that productivity increased from 0.5-0.6 tonnes/ha in 1980 to 1.8-2.0 tonnes/ha in 2000.

Unfortunately, most of the scientific-technical aquaculture developments completed between 1980 and 2000 were private initiatives having a simple character; as a rule they did not have any technical and economic basis; for this reason the efficacy of their application was poor. However, at the same time, this fact did not influence the activities of the scientific community or the salary of their staff. As a matter of fact, scientific organizations produced non-competitive scientific outputs and the State paid for developments that had no commercial demand. During the same period commercial enterprises, faced with mass supply shortage, were able to produce non-competitive products without any problems in selling them. This was the main reason why scientific-technical developments were not in demand: businesses did not see any economic benefit from the application of these developments. Having such an economic mechanism, Russia entered the period of serious economic change.

The new economic policy in Russia is more than ten years old and has touched all industries of the national economy of the Russian Federation, including fish culture. It is therefore useful to consider what problems there are in the scientific-technical sphere of the fish industry of Russia and how they are being solved by individual enterprises and the industry as a whole.

Research and development

The amount of State funding for science was much too low and there were very few requests for scientific advice from commercial enterprises. Under these conditions Russian sectorial scientific organizations had to reduce research scope, restrict scientific programmes and activities and decrease the number of research assistants. Old-fashioned equipment and materials in institutes dealing with aquaculture have not permitted research activities at high scientific or technical levels to be carried out. Under these conditions it has been impossible to produce competitive scientific outputs and the financial status of scientific organizations therefore became even worse.

The institutes are also unable to take advantage of most earlier research results because current scientific and technical developments are characterized by a narrow focus on aquaculture and biological aspects. As a rule, these studies do not have any data on the unit costs of materials and technical and labour resources; therefore it is impossible to show any clear economic benefit from their practical application.

Commercial aquaculture

Despite the fact that aquaculture farms were confronted with serious problems in selling farmed fish, they did not take steps to improve their technology. They only turned to extensive methods of management, reducing productivity to 600-800 kg/ha. The managers of the farms have not yet realized the importance of producing fish that is competitive in quality and price. Poor financial analysis in aquafarms (not considering the costs of separate

technological units and their relation to each other but only the total costs as a whole) is also a serious obstacle in accelerating scientific-technical progress. Most of the farms do not even change to rearing highly-productive fish breeds, even though this does not necessitate any large expenditure.

Problems Identified

What therefore are the main causes for the current situation in the scientific-technical development in aquaculture of Russia?

Commercial application of new technologies

Commercial aquaculture enterprises are not interested in the application of scientific-technical developments, because farm managers have not yet realized the importance of producing fish that is competitive in quality and price. Even though there are some fish farm managers who realize the value of scientific-technical work, they do not hurry to purchase these scientific results. This is because they are sure that they will be able to receive new technologies without charge, as was the case in the period of the socialist way of development. Poor economic analysis, as noted above, is also a serious obstacle to the acceleration of scientific-technical progress in aquafarms.

Standards of research results

The scientific-technical work that is proposed for application is quite weak from a technical-economic point of view. In most of the technologies developed for fish rearing there are no unit costs for material, technical or labour resources. This makes it impossible to compare them with those in current use and, what is more important, to be able to demonstrate the real economic benefits from using new technologies in practical aquaculture. It is clear that the incompleteness of the work of scientific organizations makes it impossible for them to take an active part in applying their results in commercial fish farms. This difficulty affects both the farms that are leased and the potential for mutually financing (sharing investment, risks and benefits between farmers and advisory institutions) the material and technical inputs necessary for successfully applying new technological decisions.

State policies and structures

The economic policy of the Russian Federation does not encourage the application of scientifically sound high quality products that are competitive, either at the national or international level. Those enterprises that introduce progressive developments do not enjoy any tax incentives or State preferences and thus take the risk of their application themselves. This alone is a serious deterrent against the accelerated scientific-technical development of most sectors of the national economies of Russia, including agriculture and its aquaculture component.

At the beginning of the 1990s some Ministries were broken up and some associations were established for keeping and preserving sectorial enterprises and organizations. The creation of such associations was serious and defensible but their activity showed very weak impacts on scientific-technical development, either in individual enterprises or the fish industry as a whole. The problems experienced during the period before economic reformation were not practically solved.

In the middle of the 1990s several scientific organizations became joint stock companies in order to induce them to sell their scientific-technical output; however, there were no buyers (for the reasons mentioned earlier). Now, some of these scientific organizations have ceased their activities and others are in a very bad financial situation.

Solution

Since 1995, research-and-production centres have been established. These have various patterns of ownership. Their structure includes research institutes and commercial aquaculture farms and they are introducing scientific-technical methodologies. The economic viability of the centres depends on the efficacy of these methods. The list of products and services offered is increasing and is remarkable for its diversity. Nowadays, interest in using scientific-technical methods is shared both by the scientists in research institutes and the specialists and workers in commercial enterprises, because they share the costs and risks involved. The range of funding sources has also become wider for:

- conducting research of national importance;
- realizing more competitive production;
- training specialists from other organizations and enterprises; and
- the sale of intellectual property.

Thanks to all these factors the centres have been able to stabilize their economic status.

The centres finance the revision of the technologies proposed for application from their own funds, taking into account their productive capacity characteristics and the potential “know-how” for sale to allied enterprises and developers.

Conclusions

These centres are a concrete example of transferring science from sectorial quality to the status of proprietary science. Commercial enterprises have therefore begun to look at scientific-technical activities from a different perspective. It has become very clear that the times when free science for commercial enterprises was available are over. At the same time the demand for good quality scientific-technical work has become more stringent, because its results become articles of trade and must therefore be competitive, both in the national and international markets.

At the beginning of the twenty-first century the successful development of aquaculture in the Russian Federation will be mostly determined by the level of scientific-technical achievements and the rate at which they are applied in commercial aquaculture. The stability of the interrelationships between scientific organizations and commercial aquaculture firms is crucial for future success.

THE DEVELOPMENT OF A MULTIFUNCTIONAL POND FISH FARM IN COLLABORATION WITH A RESEARCH INSTITUTE

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ABSTRACT

The privately owned Aranyponty Fish Farm is producing about 1 600 tonnes of fish (mainly common carp) annually on a fish pond area of 1 540 ha. The market size fish production is about 600 tonnes/year. “Aranyponty” is a pioneer in the development of multifunctional fish farming, and its complex activity includes recreational fisheries, ecotourism, ecological services and nature conservation. The fish farm is also actively involved in the development of various sustainable aquaculture technologies. Its development was assisted by the Research Institute for Fisheries, Aquaculture and Irrigation at Szarvas, Hungary (HAKI), which has established an on-site research station there for the further investigation of various components of multifunctionality. Multifunctionality is a good option for many pond fish farms, in order to diversify farming activities and in this way to improve profitability, environmental compatibility and the image of fish farming. This paper provides an overview of the various activities and gives examples of joint R&D work with research institutions.

Key words: *Hungary, angling, aquaculture, birds, conservation, ecology, ecotourism, environment, fisheries, image, multifunctional, recreational, sustainable*

Introduction

Pond fish farming has gone through substantial changes since 1991, during the transition of the Hungarian economy from a centrally planned system to a market economy. The dominance of the large state-owned fish farms has disappeared, and the share of privately-owned units increased from five percent in 1990 to 60 percent of the total fish pond area in 1995; by 2004, 27 000 ha were private. Besides privatization, there have been other impacts on pond fish farming, namely the increasing need to consider environmental matters and to protect aquatic resources and maintain biodiversity. Large fish pond areas have been transferred to National Parks and many pond fish farms operate in protected or environmentally sensitive areas. The cost of inputs, in particular water, has increased, and market potential has also altered due to the expansion of supermarkets and hypermarkets and the changing needs of consumers. In these circumstances pond fish farms were not able to follow the traditional production pattern (the “business as usual” scenario) but had to explore new possibilities in order to keep their businesses viable and sustainable.

One possibility was to diversify fish farm activity and, besides traditional pond fish production, to commence other on-farm activities that might provide additional income and also improve the image of the farm. The most common on-farm activity besides fish production is providing services for anglers. Several farms turned some of their smaller fish ponds into angling ponds and built some facilities for servicing visiting anglers. However,

there are some other special conditions at pond fish farms. These include the natural environment around the ponds, with its special flora and fauna, and the existence of traditional fish farming equipment and tools; these conditions may be utilized for the benefit of the farm through providing services for tourists. The application of the multifunctional approach proved to be a realistic option for many fish farms for their survival and sustainable development.

Development of a Multifunctional Fish Farm

The Aranypony Fish Farm was established in 1989, when a formerly state-owned fish pond system was bought by a private entrepreneur using a special credit scheme introduced by the government in order to facilitate privatization. The new owner, who had grown up in a fisherman's family and had always been working in fish culture, gradually reconstructed the dilapidated buildings and badly eroded fish ponds and also built new facilities. Since 1989 the farm has become the largest private fish farm in Hungary and has about 1 000 ha of fish ponds in the Retszilas Nature Reserve area.

Since the farm is located in a Natural Reserve area under the Ramsar Agreement, there has been a need to harmonize fish farming activities with nature conservation, with special regard to the various protected birds. The rich bird population may provide benefits to the farm through ecotourism; however, the high population of cormorants has a highly negative impact on fish production.

In the mid-1990s the management investigated various options to consider how to profit from these special conditions and yet to minimize negative impacts. That was when the concept of multifunctionality was seriously taken into account during the elaboration of business and development plans. Since then, the farm has systematically developed its activities and facilities in order to harmonize the various components and to find their appropriate place in the complex system. The range of activities includes fish production and services for anglers and tourists, as well as organizing cultural and training programmes and conferences. During its development the farm has been actively collaborating with environmental and water authorities and also with R&D institutions, especially the Research Institute for Fisheries, Aquaculture and Irrigation (HAKI), which is its main R&D partner.

Main Components of the Multifunctional Activity

Conventional pond fish production

The main farm unit at Réti-major with its 1 000 ha fish pond area consists of 12 large ponds (10-70 ha), 16 smaller ponds (1-5 ha) and 21 over-wintering ponds. The farm operates a modern fish hatchery, which produces about 100 million fish larvae in a propagation season lasting from February until June. The farm rents another 600 ha of fish pond area elsewhere in Hungary, including a 50 ha area near Budapest that also functions as a fish distribution centre for the capital. The total annual production of the farm is about 1 600 tonnes, of which 75 percent is common carp and 20 percent Chinese carps (silver carp and grass carp). Other species, such as pike, pike-perch, catfish, tench and ornamental fish, are also produced in smaller volumes. Thirty-five people work at the farm full-time and an additional five during harvest. The annual turnover of the farm was €820 000 in 2003.

Organic fish production

The Aranypony Fish Farm was a pioneer in the initiation of organic fish production in Hungary and took a leading role in the elaboration of the Hungarian Standard for Organic Fish Farming. Aranypony was one of the first fish farms in Hungary that contracted

BIOKONTROLL HUNGARIA for certifying its production. Organic fish farming has been carried out since 2001 and, after a transition period, Aranyponty supplied organic common carp and silver carp to the market for the first time during the Christmas period in 2002.

Active involvement in research and development

The main objective of the R&D work, which is carried out in close collaboration with HAKI, is the development of non-conventional fish pond technologies and management practices for the improved use of water resources, protection of the environment and better integration of pond fish farms within the agricultural ecosystem. HAKI established two well-equipped laboratories at the farm, where specific projects are carried out as follows:

- studies on nutrient budgets (N, P, suspended solids) and water budgets (inflow, seepage, evaporation, outflow);
- investigations on bird activities and on the interaction of fish culture with other human activities in the region;
- assessment of the role of the various functions of fish ponds in a particular agricultural ecosystem;
- development of collections and gene banks of indigenous fish species that are not commonly cultivated in Hungarian pond aquaculture, such as tench (*Tinca tinca*), ide (*Leuciscus idus*) and Crucian carp (*Carassius carassius*); and the
- development of water-efficient and environmentally-friendly pond aquaculture systems using water recirculation and biological treatment.

In addition to R&D work in aquaculture, the Aranyponty Fish Farm also collaborates with the Ministry of Environment and Rural Development and the Hungarian Ornithological and Nature Conservation Society.

Services for anglers

The angling industry is the main customer of the Aranyponty Fish Farm, which sells about 70 percent of the common carp and carnivorous species produced in Hungary for stocking angling waters. The farm also provides direct services to anglers in its Örspusztá Anglers Centre, where ponds of different sizes with various fish species are available for recreational fishermen. Anglers can catch fish from jetties along the shoreline of the ponds or from hired boats. The centre has a car park for 60 vehicles, and a visitor centre where a buffet, an anglers' shop and even a place to clean fish are available. For those family members and children who are not angling, playground, sports facilities, and bicycles for rent are available. The sale of fish to angling waters and from direct services to anglers in the Örspusztá Anglers Centre is a major source of revenue for the farm.

Services for ecotourism

The Rétszilás Natural Reserve area is an ideal place for the type of tourism in which the goals are recreation in a natural environment, the observation of wildlife, nature photography, bird watching, fishing, horseback riding and other family programmes in a green and quiet surrounding. The highest value of this Natural Reserve area is the rich bird population. More than 220 bird species are registered in the area, of which 181 are protected and 32 are highly protected. Besides birds, there is a wetland that is rich in invertebrates, insects and amphibians. Among mammals, the highly protected otters find an excellent habitat in the area. Geothermal water with medical value is also available in the farm area, which can be used for the natural treatment of some specific diseases.

The geographic location of the area is very favourable, since it is only about an hour away from Budapest and only 40 minutes from Balaton and Velence Lakes. Individual guest houses

and a small hotel with eight rooms are also available for the visitors. In the fishermen's pub of the farm, visitors can enjoy fish and game dishes prepared according to traditional recipes, together with local wines. From the elevated terrace of the pub there is a nice panoramic view on the surrounding water world.

Training, demonstration and conferences

A fisheries museum has been established at the farm, where a unique collection of traditional fishing tools and relics of fishermen's life and the history of Hungarian fisheries are on display in a rehabilitated old thatched roof building. An open area with a pond, an ancient fisherman's house and fishing gears can also be seen in the farm centre. Training programmes on wildlife and fisheries are regularly organized in the museum.

There are training and demonstration programmes at the farm on the use of natural materials like reeds, willows and bulrushes to produce household tools and decorations. These programmes contribute to the preservation of some traditional methods that were commonly used in wetland areas in the past. The farm has a conference centre for 60-70 participants, which is equipped with modern facilities and offers an excellent venue for smaller conferences and company meetings.

The Aranypony Fish Farm also organizes the annual "St. Peter's Fishermen's Day", which is a popular gathering in Hungary with both professional and cultural programmes.

Conclusions

Production driven, large-scale traditional pond fish culture cannot meet the new challenges that European freshwater aquaculture faces. Pond fish farms have to explore their potential to find out how they can diversify their activities in order to be able to produce various fish products and to provide services for which there is demand by the market and the society. Pond fish farms may benefit from their relative extensiveness by working in a natural-like environment and using traditional fish production methods. The example of the Aranypony Fish Farm clearly shows the business opportunities provided by the diversification of farm activities. The development of a multifunctional fish farm should be based on careful market survey of the demand for various products and services; environmental and water quality regulations also need to be taken into account, however. In addition, a realistic assessment of the local conditions and capacities that may be improved through collaboration with R&D institutions should be made. multifunctionality may include various components according to the specific conditions; however, it may not be the only option for sustainable development for all pond fish farms. The role of pond fish farms in the complex agricultural ecosystem requires more studies, which also emphasize the need for collaboration between pond fish farms and research institutions. The success of multifunctional pond fish farms is beneficial, not only for the specific farm but also as a contribution to the improvement of the image of pond fish farming generally.

AQUACULTURE EDUCATION, RESEARCH AND EXTENSION IN TURKEY

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ABSTRACT

The aquaculture sector in Turkey has enjoyed rapid development during the last decade with full public support, cheap labour and lack of strict environmental regulations. Annual production reached over 80 000 tonnes in 2003 from around one thousand farms producing rainbow trout, seabass, seabream, tuna and common carp. Its share in total fishery production is around 10-12 percent in volume and around 25 percent in value terms. Currently, the country has significant know-how and research capacity, although it is not well organized. R&D activities are mainly performed by Fisheries Faculties and four Research Institutes of the Ministry of Agriculture and Rural Affairs. There are 13 fisheries faculties and five departments at agriculture faculties providing undergraduate and graduate education in fisheries (including aquaculture) and aquatic sciences. Each year more than 300 students graduate from these faculties but the numbers employed by the sector are very limited, and mainly in marine aquaculture. Extension service seems to be the weakest link of the support services for development. Aquaculture producers have recently started organizing themselves and have formed three associations, one fisheries foundation and a fish promotion group.

The lack of a natural resource (zone) management system; low species and product diversity; insufficient legal and institutional structures; poor quality and utilization of manpower; inadequate organization of research and development activities, the dissemination of research results, and partnerships between stakeholders; lack of producers associations; and inefficiencies in public institutions seem to be the major constraints for the development of environmentally sound and economically viable aquaculture. Thus the Government of Turkey should increase emphasis not only on production but also on environmental sustainability, food safety and industry competitiveness.

In this paper the development and current status of Turkish aquaculture in terms of production, species and product diversity, legal, institutional and regulatory framework, education, research, extension services and producers associations are reviewed.

Key words: Turkey, aquaculture, constraints, development, education, extension, research

Introduction

Turkey is a large country of about 779 452 km² and a relatively young population that approaches 70 million and is increasing at around two percent per year. The country has rich and diverse water resources, ranging from fresh to brackish and marine waters: 8 333 km of coastline; 151 080 km² of economic coastal zone; 177 714 km total river length; around

900 000 ha natural lakes; and 500 000 ha of dam reservoirs (Çelikkale, Düzgüneş and Okumuş, 1999). Despite these large attributes, Turkish fisheries have stagnated at an annual production of around 600 000 tonnes and depend mainly on small-scale and largely small pelagic fisheries. Freshwater fisheries production has also leveled off at around 40 000-50 000 tonnes (DIE, 2003).

Similar to global trends, the demand for fish is increasing in Turkey. As the landings of fish from capture fisheries fail to meet the demand, the role of aquaculture is increasing and it has become an important and viable sector, with an average annual increment of over 30 percent since 1992. It has been widely acknowledged that the projected demand for fish will not be met without growth and technological advancements in aquaculture to supplement the traditional fisheries. The development of a robust aquaculture industry will provide safe and healthy food products for consumers and create jobs. It also has potential to support wild stocks and increase exports of fishery products, thus benefiting the balance of trade. In addition, aquaculture technologies and consulting services for private industry and enhancement efforts, as well as superior, disease-free strains of broodstock, are valuable exports that contribute to the national economy.

Currently, the Government of Turkey is committed to ensuring the responsible and sustainable development of the aquaculture industry. Recent efforts in relationships with international organizations, legal arrangements such as environmental impact assessments (EIA), and direct income support for fish farms are clear expressions of this commitment. The major objective is to support the sustainable development of the aquaculture sector, with a focus on increasing production and diversity, enhancing public confidence in the sector and improving the competitiveness of the industry.

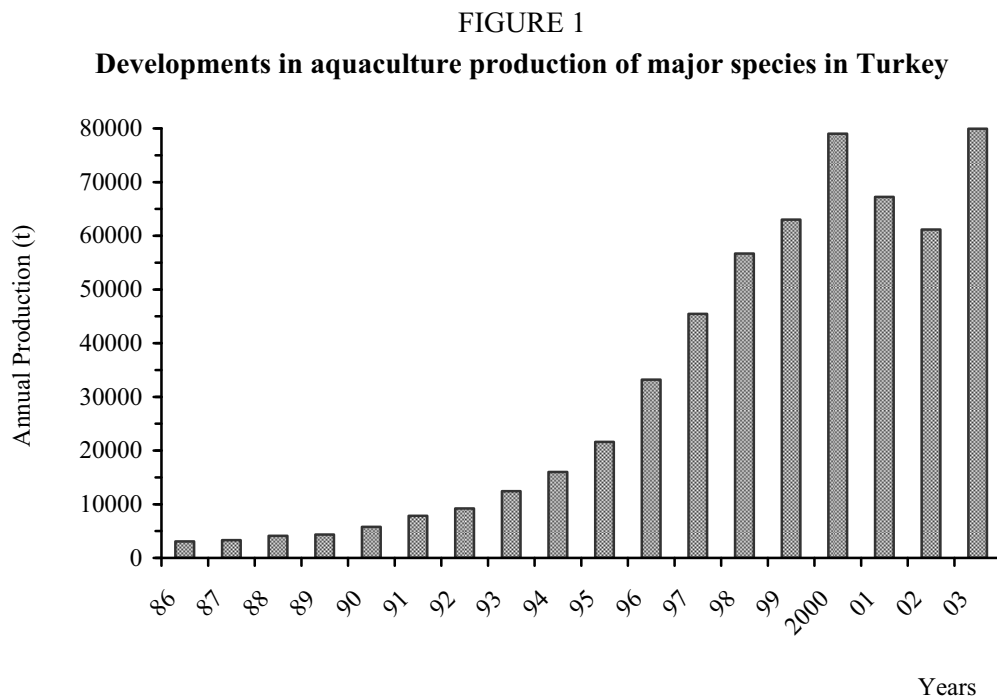
The recent rapid growth of the aquaculture industry has created a new demand for all kinds of technical information and services. As novices enter aquaculture, they seek guidance from knowledgeable and experienced persons, commonly from public institutions, trade and marketing associations, producers organizations and professional societies. The main objectives of this paper are to provide a review of aquaculture development, education, training, research and extension services in Turkey, and to discuss the potential role of producers associations.

Development of Aquaculture in Turkey

Historical development

Aquaculture in the Mediterranean region is an activity which began many centuries ago; some form of extensive aquaculture has long been practised in the Mediterranean lagoons of Turkey (called “dalyan fisheries”) but modern aquaculture started in the early 1970s. Two freshwater fish, rainbow trout (*Oncorhynchus mykiss*) and common carp (*Cyprinus carpio*), were the pioneering species. Culture of the major Mediterranean species, seabass (*Dicentrarchus labrax*) and seabream (*Sparus aurata*) commenced in the mid-1980s. However it was not until the “anchovy crisis” in the late 1980s that aquaculture gained significant attention for its potential. A sharp drop in the production of Black Sea small pelagics led to a search for alternatives to traditional fisheries. During the 1990s, Atlantic salmon (*Salmo salar*) and rainbow trout mariculture in the Black Sea attracted considerable attention and effort. There were also some attempts to culture kuruma shrimp (*Metapenaeus japonicus*) on the Mediterranean coast (Okumuş, Düzgüneş and Çelikkale, 2000). Another major development was a joint project supported by the Government of Japan on developing hatchery technology for Black Sea turbot (*Psetta maxima*). The initiation of bluefin tuna (*Thunnus thynnus*) farming (“fattening” or “capture-based aquaculture”, see Ottolenghi *et al.* 2004) in the

Mediterranean and Aegean Seas was the main development at the beginning of the new millennium. As a result, aquaculture became a significant commercial industry and production increased rapidly (Figure 1).



Source: Çelikkale, Düzgüneş and Okumuş (1999); DIE (2004)

Current status

The Turkish aquaculture sector enjoyed rapid development from 1992 to 2000, with full public support, cheap labour and a lack of strict environmental regulations. Aquaculture, mainly fish farming, plays an increasingly important role in Turkey (Table 1) today. By 2003 Turkey had become the twenty-seventh largest aquaculture producing country in the world, while in Europe it follows Norway, Spain, France, Italy, UK and Greece (FAO, 2004). Its share in total fishery production was around 14 percent in volume and 25-30 percent in value in 2003.

More than half (56%) of the aquaculture production is obtained from freshwater and the rest from coastal aquaculture, while in terms of value it is the reverse. Approximately 45 percent of aquaculture production comes from the Aegean region (province of Muğla), followed by the Black Sea, Marmara, Mediterranean and Central Anatolia. Due to the lack of a comprehensive data collection system the exact number of employees working in Turkish aquaculture sector is not known. However, more than 5 000 employees may work in the sector and related activities (Okumuş, 2003). Marine fish farming is mostly developed by large private enterprises; local communities are rarely involved. Thus, only freshwater aquaculture constitutes a valuable tool for promoting rural economic development.

The development of aquaculture in Turkey corresponds to high-demand species (relatively luxury species), i.e. mainly carnivorous fish such as trout, seabass, seabream, turbot, tuna, etc. Species low in food webs, such as carps and bivalves, had a very limited chance. Thus, the sector can be characterized by few species, system and product diversity, small family-owned farms and a production-oriented approach.

TABLE 1

Trends in fisheries and aquaculture production and per capita fish consumption in Turkey

Year	Capture (tonnes)		Aquaculture		Total (tonnes)	Per capita consumption (kg)
	Marine	Inland	(tonnes)	(%)		
1986	539 565	40 280	3 075	0.5	582 920	8.5
1987	585 763	38 650	3 500	0.6	627 913	7.6
1988	627 369	44 535	4 100	0.6	676 004	8.7
1989	409 959	42 833	4 354	1.0	457 116	6.3
1990	342 017	37 315	5 782	1.5	385 114	6.2
1991	317 425	39 401	7 835	2.2	364 661	5.4
1992	404 766	40 370	9 210	2.0	454 346	7.5
1993	502 031	41 575	12 438	2.2	556 044	7.8
1994	542 268	42 838	15 998	2.7	601 104	8.2
1995	557 138	44 983	21 607	3.3	649 200	9.8
1996	474 243	42 202	33 201	6.0	549 646	8.5
1997	404 350	50 460	45 450	9.1	500 260	7.5
1998	432 700	54 500	56 700	10.4	543 900	8.3
1999	523 634	50 190	63 000	9.9	636 824	7.6
2000	460 521	42 824	79 031	13.6	582 376	8.0
2001	484 410	43 323	67 244	11.3	594 977	7.6
2002	522 744	43 938	61 165	9.7	627 847	6.7
2003	463 074	44 698	79 943	13.6	587 715	6.8

Source: Okumuş, Atasaral and Serezli. (2003); DIE (2004)

The secondary support services, namely feed, equipment and consultancy, also developed rapidly and the needs of the sector are provided. In addition, representatives of foreign companies, particularly from EU, provide contacts for imports of equipment and technology.

Aquaculture production figures have been gathered separately from capture fisheries since 1986. In that year production amounted to only 3 075 tonnes, consisting of less than 0.5 percent of overall fisheries production (Table 1). However, it increased by an average of 20 percent per year between 1986 and 2002, mainly as a result of improved know-how and technology, investment in the sector and the expansion of domestic and European markets. In 2002, the Turkish aquaculture industry produced 61 533 tonnes, valued at US\$212 million (DIE, 2003).

Production has increased considerably since 1992, but not the species, product or system diversity. In 1995, for example, the commercially cultured species were rainbow trout, seabream, seabass, Atlantic salmon, carp, mussels and shrimp. Today, the production of

Atlantic salmon, shrimp, mussels and even carp has almost ceased (Figures 1 and 2). Culture practices and other developments in major species currently cultured are summarized below.

Trout

The most dramatic example of aquaculture success happened in the development of trout culture. Its production increased at an average of 25 percent annually between 1994 and 2003 and Turkey became one of the major trout producers globally. Annual production once approached 50 000 tonnes but has dropped to about 35 000 tonnes as a result of the national economic crisis in 2000 (Figures 1 and 2). Trout farming, mainly *Oncorhynchus mykiss*, and very small amount of *Salmo trutta* and *Salvelinus fontinalis* (Okumuş, Düzgüneş and Çelikkale, 2000), represents the most widespread form of intensive inland aquaculture, mainly using concrete raceways and cages located in lakes, dams and brackishwater of the Black Sea. The on-growing period from fry to table-size fish lasts between 16-24 months in raceways, while in cages, particularly in the Black Sea, juveniles of 20-30 g stocked in October to November can grow over 500 g in six months (Şahin, Okumuş and Çelikkale, 1999; Okumuş *et al.* 2002). However, due to high summer temperatures (sometimes approaching 28-30 °C) fish cultured in marine cages have to be harvested at the beginning of summer. Trout culture has developed as a small- and medium-scale family activity and there were 950 farms by 2003. Large-scale farms, with a capacity of 100-1 000 tonnes/year, represent just around three percent of total numbers but are responsible for about 40 percent of total production. Even most of the small farms maintain their own broodstocks and produce their eggs and juveniles (Okumuş, 2002).

Despite increased production, the only diversification is the production of relatively large (500-1 200 g) trout in marine cages in the Black Sea. Recent biotechnological developments, such as all-year round egg and monosex/sterile stock production, are rarely practised. Rainbow trout is considered a middle-value product, marketed whole fresh and destined for the domestic market. The high volume of this production is also its major constraint because of the progressive saturation of the demand. However, the market seems to be increasing at a slow pace, and the sector is attracting new investments; thus an increase in production can be expected.

Seabass and seabream

Turkey is currently one of the leading countries in seabass and seabream production, which increased rapidly during the 1990s and reached around 38 000 tonnes in 2003 (Figures 1 and 2). Approximately 43 percent by volume and 60 percent in value terms of the annual national total aquaculture output comes from these two species. Their high product value and demand in the European market have fuelled production but at the same time reduced prices dramatically.

There are 18 hatcheries in the country with a total capacity of 50 million seabass and 30 million seabream fry, but some of these hatcheries are not operational. Seabass and seabream farms are relatively large in comparison to trout farms. There are approximately 250 farms concentrated in the provinces of Mugla and Izmir in the southern Aegean Sea. A small amount of seabass is also produced (*ca* 400 t) in the Black Sea. The farms were relocated towards relatively more open areas or secondary bays in 2000 (Okumuş, 2003). Thus the types and sizes of the cage systems employed have changed. These species are also grown in earthen ponds in the province of Mugla. There is only one high-tech (re-circulation) land-based on-growing farm.

Fry are stocked in on-growing units during late spring; the growing period lasts about 16-18 months in the Aegean Sea and an extra summer in the Black Sea. Fish are harvested during

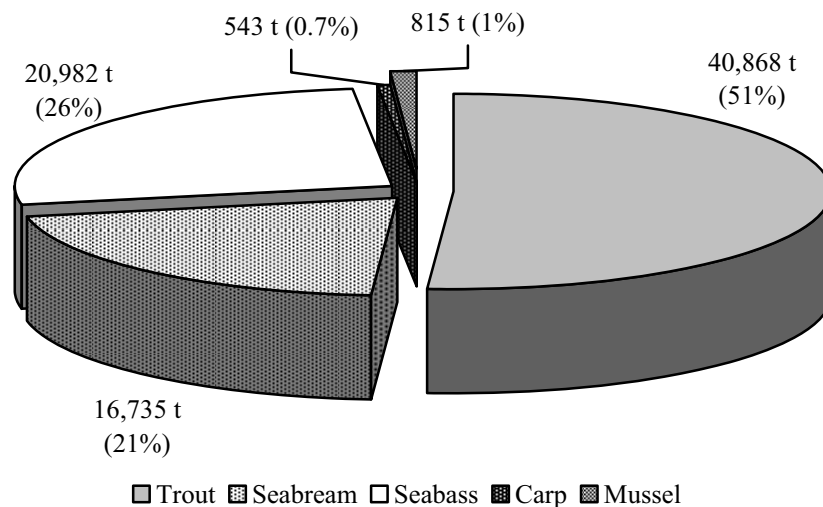
the summer and autumn months and marketed as whole fresh fish. The major part (~60%) of the production is exported to European countries, namely Italy, France, Spain and Germany. In spite of temporary export bans applied by the EU during the late 1990s, Turkey currently has no particular problems concerning exports to the EU due to special agreements and alignment with EU quality standards. Fish prices in Turkey have suffered, particularly due to the economic crisis in 2000 and market saturation. However, there seem to have been some positive developments in terms of production and market demand; production increased significantly in 2003 (Figure 1).

Carp

Common carp farming is practiced in 70 farms located in regions with a relatively mild climate. Current production is just over 500 tonnes (Figure 2). It is also the only freshwater species used for re-stocking and introductions, mainly into hydroelectric and irrigation dams. There are few public hatcheries producing juveniles for re-stocking and distributing producers. In spite of the very low fish and animal protein consumption in inland areas where conditions are suitable for carp farming, governments have failed to promote developments in this direction.

FIGURE 2

Current aquaculture production of major species in Turkey (DIE 2004)



Other species

The culture of a number of other species are being considered and tried in recent years. Unfortunately, most attempts failed due mainly to a lack of domestic market and know-how, while some of these species are poorly understood and require research to develop efficient culture techniques.

Atlantic salmon culture was tried during the 1990s in the Black Sea. Annual production once reached around 800 tonnes/year but it was not successful, due to high summer temperatures. Mussels (*Mytilus galloprovincialis*) and kuruma shrimp were the only shellfish species cultured during the 1990s. Annual production of these species reached 2 000 tonnes and 300 tonnes respectively during 1996-1998. Although official figures have not been released yet, around 3 000 tonnes of tuna are produced (fattened) annually by five farms.

Mariculture in the Aegean and Mediterranean has been dominated for a long time by two species, seabass and seabream but, during recent years, studies have concentrated on other sparids (*Pagellus erythrinus*, *Dentex dentex*, *Pagrus pagrus*, *Pagrus major*, *Diplodus sargus*, *Puntazzo puntazzo*) and Carangid yellowtail (*Seriola dumerili*). Some of these species have started to contribute to the diversification of production at the commercial level.

Since April 1997, a collaborative project between the Japan International Cooperation Agency (JICA) and the Ministry of Agriculture and Rural Affairs (MARA) Central Fisheries Research Institute in Trabzon has been working to develop hatchery technology and sustainable seed production of Black Sea turbot (*Psetta maxima*). The target production was 10 000 juveniles of 100 mm total length (Hara, 2002). At present, hatchery technology has been developed and this target has been reached. The juveniles produced are either used for re-stocking or distributed to private farms and research institutions for trial purposes. Although problems in the on-growing phase remain to be addressed, this is one of the most promising species for the near future. There is another JICA-MARA initiative directed towards resolving constraints on commercializing this species.

Legal, institutional and regulatory framework

The Ministry of Agriculture and Rural Affairs (MARA) is the legal authority responsible for overall fisheries and aquaculture administration, regulation, development and technical assistance. The Aquaculture Department in the Directorate General for Production and Development (DGPD) is responsible for inland fisheries and aquaculture. In addition, the Directorate General for Agricultural Research (DGAR) is involved in aquaculture through research activities, while aquaculture data is collected jointly by DGPD and the State Statistics Institute (SSI).

Fisheries activities (including aquaculture) are regulated by framework Fisheries Law No. 1380, enacted in 1971. The Law does not address aquaculture issues in detail, particularly new developments. Thus, regulations and circulars are issued by MARA in order to be able to follow the developments. Unfortunately, this situation sometimes reflects a disharmony between the way the sector functions and the existing legislation and regulations that govern it. Currently, the Fisheries Law is being revised according to the EU fisheries *acquis*¹⁷ and the issues related to aquaculture are also being updated.

Article 13 of the Fisheries Law states that those who wish to cultivate aquatic species for commercial purposes are obliged to apply to MARA for a licence. Permission is given by MARA if no adverse effects are perceived in terms of public health, the national economy, navigation or science and technology. Thus, the applicants need to have obtained the approval of various Ministries (e.g. transport, environment, culture and tourism, forestry, etc) and state departments (treasury, coastguard and navigation, hydrography and oceanography), confirming that the proposed culture activity would have no adverse effect on environment, navigation etc. Unfortunately, this makes the licensing procedure quite complex and slow.

As mentioned earlier, Turkey is trying to coordinate aquaculture activities among many departments by means of numerous regulatory acts to balance the growth of viable aquaculture industries with the increasingly important issue of the environment; at the same time Turkey is confronting the same key environmental issues, including visual or aesthetic pollution, organic effluents, navigational problems, disease, the use of therapeutic agents and food safety. In order to maintain an environmentally sound development an EIA (Environmental Impact Assessment) is required for individual sites for which fish farmers

¹⁷ Common Fisheries Legislation

apply for a licence. In addition, a product quality control system has been developed, based on relevant EU regulations. Hence, fish farms are periodically subjected to general hygiene control.

Human Resources: Education and Training

Historically, fisheries education in Turkey started in the 1950s, but the first undergraduate and postgraduate degree programmes covering aquaculture were initiated by the Faculty of Agriculture at the University of Ankara in the late 1970s. Schools, departments and faculties providing fisheries (including aquaculture) education increased after the 1980s.

High schools

Actually, fisheries education starts in high schools (after the age of 15). There are seven high schools providing fisheries and aquaculture education during three or four year programmes. One of these high schools is run by MARA, while others are part of the National Education Curricula of the Ministry of Education. In addition to basic science classes, fisheries and aquatic science related subjects are also covered in these programmes (Table 2). Besides theoretical teaching, students are given laboratory and field practice and they are expected to undergo practical training/work in the fisheries/aquaculture sectors outside the schools for 30 days. Around 20 to 30 students graduate from each of these high schools annually. They may attend “Vocational High Schools” without any additional requirement.

Vocational high schools

Vocational high schools are academic units of universities providing two-year degree education in various subjects. In addition to students coming from fisheries high schools they recruit students from ordinary high schools through the central university entrance examination. Currently there are around 20 such schools having fisheries programmes. The main fisheries and aquaculture subjects taught in these programmes are presented in Table 3. In addition to courses, laboratories and practical work, students in these schools have to complete 30 to 40 days of practical training in sector or research institutions. They graduate with the title of “technician”.

Undergraduate and graduate degrees

Specific aquaculture courses, undergraduate or graduate degree opportunities are not available. However, the programmes of fisheries faculties and departments at agriculture faculties cover aquaculture related subjects well. There are 13 fisheries faculties and five departments at agriculture faculties (Table 4). Fisheries faculties are mostly located in coastal cities: three in the Black Sea, one near to the Sea of Marmara and the Bosphorus and one next to the Dardanelles, two by the Aegean Sea and four on the Mediterranean coast. However, there are only two in inland areas, one in the southwest (lakes region) and the other in the southeast of Turkey. In contrast, fisheries departments at agriculture faculties are located in inland regions (central, eastern and south-eastern Anatolia) (Figure 3).

TABLE 2
Subjects taught in Fisheries High Schools

Courses	Hours/ week	Courses	Hours/ week
First Year		Third Year	
Technical Drawing	2	Fish Handling and Processing	2
Biology	2	Marine Fish Culture	2
Introduction to Fisheries	2	Fish Diseases	
Planktology	2	Project Formulation in Aquaculture	2
Laboratory and Practices - 1	9	Laboratory and Practices - 3	19
Second Year		Fourth Year*	
Aquatic Biology	2	Marketing	1
Aquatic Ecology	2	Freshwater Fish Culture	2
Mollusc and Crustacean Culture	2	Marine Fish Culture	2
Freshwater Fish Culture	2	Fishing Technology	
Fish Nutrition and Feeds	2		
Aquarium and Aquarium Fishes	2		
Laboratory and Practices - 2	15		

* Only in the Ministry of Agriculture and Rural Affairs Fisheries High School

TABLE 3

Aquaculture related courses provided in fisheries programmes of vocational high schools

Courses	Hours/week	Courses	Hours/week
Introduction to Fisheries	3	Water Quality and Analysis	5
Marine and Freshwater Biology	4	Fisheries Legislation and Regulations	3
Fish Biology	4	Marine Fish Culture	2-3
		Fish Diseases	5
Fish Nutrition and Feeding	4	Planning Aquafarms	3
Live Feed Production	4	Breeding Aquarium Fishes (Elective)	3
Freshwater Fish Culture	3-4	Shellfish Culture (Elective)	3
Fisheries Ecology	3	Fish Quality Control (Elective)	3
Seafood Processing Technology	5	Seaweed Culture (Elective)	3

TABLE 4

Faculties and departments providing education, research and other services on aquaculture related areas

Name of Faculty or Department, City	Activities	Major Areas	Scientists*
Fisheries Faculty, Istanbul	B.Sc., M.Sc., Ph.D., Research	Inland and marine, salmonids, sturgeon, husbandry, feeding and diseases	10
Fisheries Faculty, Sinop	B.Sc., M.Sc., Ph.D., Research	Inland and marine, salmonids, shellfish, sturgeon, husbandry, feeding, diseases	12
Fisheries Faculty, Egirdir	B.Sc., M.Sc., Ph.D., Research	Inland, fish diseases	10
Fisheries Faculty, Izmir	B.Sc., M.Sc., Ph.D., Research	Marine fish, shellfish, husbandry, feeding, diseases	22
Fisheries Faculty, Elazig	B.Sc., M.Sc., Ph.D., Research	Inland aquaculture, crayfish, fish diseases	6
Fisheries Faculty, Adana	B.Sc., M.Sc., Ph.D., Research	Marine fish and crustaceans, husbandry, feeding, diseases	8
Faculty of Marine Sciences, Trabzon	B.Sc., M.Sc., Ph.D., Research	Marine and inland, salmonids, sturgeon, marine fish, bivalves, crayfish, husbandry, feeding, genetics, diseases	3
Fisheries Faculty, Iskenderun	B.Sc., Research	Genetics	6
Fisheries Faculty, Rize	B.Sc., M.Sc., Research	Salmonids, husbandry, diseases	4
Fisheries Faculty, Canakkale	B.Sc., M.Sc., Research	Fish feeding	2
Fisheries Faculty, Mersin	B.Sc., M.Sc., Research	Fish husbandry	7
Fisheries Faculty, Antalya	B.Sc., M.Sc., Research	Crustacean culture	2
Fisheries Faculty, Mugla	B.Sc.	Mariculture Mediterranean of species	3
Fisheries Department	B.Sc.**, M.Sc., Ph.D., Research	Inland aquaculture, husbandry, diseases	5
Fisheries Department, Erzurum	B.Sc.**, M.Sc., Ph.D., Research	Inland, salmonids husbandry	4
Fisheries Department, Van	B.Sc.**, M.Sc., Research	Inland, trout husbandry	3
Fisheries Department, Tokat	B.Sc.**, M.Sc., Research	Inland, trout husbandry, diseases	2
Fisheries Department, Kahramanmaras	B.Sc.**	Inland fisheries, carp and trout culture	1

* Those having Ph.D. degrees and studying teaching aquaculture

** B.Sc. fisheries programme in agriculture engineering

FIGURE 3

Locations of Fisheries (FF) and Marine Science (FMS) Faculties, the Fisheries Departments (FD) of Universities and Fisheries Research Institutes (FRI) of the Ministry of Agriculture and Rural Affairs (MARA)



Besides undergraduate degrees most of these faculties and departments offer masters (M.Sc.) and doctorate (Ph.D.) degrees in fisheries and aquaculture. Master programmes last a minimum of one and a half and a maximum of three years. In general, students take courses (at least 7) during the first year, and carry out their projects and submit their theses in the second year. The duration of Ph.D. programmes varies from three to six years; students have to attend and pass at least seven courses, and also pass a proficiency exam before presenting their PhD project proposals.

In spite of the high number of degree programmes, short-term vocational training courses are not available. Occasionally, MARA Fisheries Research Institutes (FRIs) organize such courses for the technical staff of MARA and for fish farmers.

Research and Development

Fisheries and aquaculture research activities in Turkey are performed by the fisheries departments of various universities and the FRIs of MARA. In addition to educational responsibilities, university departments perform basic and applied aquaculture-related research. Some of these departments have large research facilities and a multi-disciplinary staff of scientists engaged in a variety of aquaculture projects (Table 4).

At present, there are four MARA research institutes dealing with aquatic, fisheries and aquaculture research. Two of the FRIs, located in central and eastern Anatolia, are in charge of inland waters, while the other two deal with both coastal and inland waters (Figure 3); the topics and facilities of these institutes and centres are summarized in Table 6. Emphasis is given to applied research focusing both on existing commercial species and new species and system development.

TABLE 5
Aquaculture related major courses offered in fisheries faculties and fisheries departments of agriculture faculties

Courses	Hours/week		Hours/week
Fisheries Faculties			
Fish anatomy and physiology/Fish biology	4	Planktology and plankton culture / Live feed production	2-4
Fish systematics	4	Fish Diseases	4
Water chemistry and quality	4	Fish immunology and vaccination	2
Genetics	3	Diseases of aquarium fishes	1
Freshwater fish culture	4	Shellfish diseases	1
Coldwater Fish Culture	4	Fish parasites	1
Warmwater Fish Culture	4	Fisheries legislation and regulations	2
Marine Fish Culture	4	Feeding physiology	3
Bivalve and crustacean culture	4	Fish breeding	1
Aquarium Fishes and Breeding	4	Fisheries economics	2
Fish nutrition and feed processing	4	Quality control and hygiene	2-3
Planning and designing aqua-farms	3	Biotechnology in fisheries	2
Automation in aquaculture	4		
Fisheries Department of Agriculture Faculties			
Fish Anatomy and Physiology	4	Fish Diseases	4
Shellfish Bio-ecology and Culture	4	Marine Fishes and Mariculture	4
Plankton and Plankton Culture	4	Freshwater Fishes and Their Culture	4
Fish Biology (Elective)	4	Fish Breeding (Elective)	3
Aquarium Fish and Breeding (Elective)	4	Seaweed Culture(Elective)	4
Water Quality in Aquaculture (Elective)	4	Fish Transport Systems (Elective)	2
		Project Formulation (Elective)	3

TABLE 6

Fisheries research institutes and production and development centres in Turkey

Name of Institute	Date	Technical staff*	Areas	Facilities
Central Fisheries Research Institute – Trabzon	1987	41 (9)	Aquatic ecology; water pollution; fisheries biology and technology; aquaculture; breeding and genetics; fish health management; training and extension	Marine hatchery and grow-out units (capacity: 100 000 larvae/year); sea cages; freshwater (salmonid) research unit
Mediterranean Fisheries Research, Production and Training Institute	2004	45 (12)	Marine aquaculture; fisheries and ecology; lagoon management; warmwater, cold water ornamental freshwater fish culture; fish diseases; limnology; re-stocking	Marine hatchery and on-growing units; carp and trout hatcheries; ornamental fish breeding units; land-based on-growing units
Egirdir Fisheries Research Institute	1987	27 (1)	Freshwater fisheries and ecology	...
Keban Fisheries Research Institute	1998	25	Freshwater ecology; fisheries; aquaculture	...

* Numbers in parentheses indicate those with Ph.D. degree

Examples of recently completed and ongoing projects are:

- rainbow trout (*Oncorhynchus mykiss*) mariculture on the Black Sea coast;
- structural and productivity analyses of fish farms in the Black Sea region;
- ecology and hatchery production of sea trout (*Salmo trutta*);
- population genetics of Turkish brown trout (*Salmo trutta*) stocks;
- development of fish culture in the Black Sea – turbot hatchery techniques;
- sturgeon conservation and culture;
- population structure of Turkish brown trout (*Salmo trutta*) stocks;
- turbot re-stocking in the Black Sea;
- potential environmental effects of marine cage farming;
- alternative species for Mediterranean aquaculture;
- rainbow trout bacterial diseases and chemotherapeutics widely used in treatments;
- evaluation of freshwater resources for aquaculture development;
- sustainable aquaculture modeling for the Beymelek Lagoon;
- culture of European eels (*Anguilla anguilla*)
- cyst production of *Artemia* spp. under ambient conditions of the Mediterranean; and
- out-of-season rainbow trout egg production through photoperiod regimes.

Other activities of FRIs include:

- publications, including a scientific journal (Turkish Journal of Fisheries and Aquatic Sciences, issued by CFRI – see www.trjfas.org), newsletters and project reports and outputs;

- training for technical staff and farmers; and
- workshops and seminars.

Fisheries and aquaculture projects are mainly state (public) funded. The major national sources are MARA, university research funds, the Scientific and Technical Research Council of Turkey (TUBITAK) and the State Planning Organization (SPO). Projects are supported by MARA through FRIs. Related university departments can also join these projects. University research funds are available for postgraduate (i.e. theses) and some advanced projects. TUBITAK and SPO allocate some funds for advanced high-tech projects submitted by universities.

So far UNDP and FAO, and some international development agencies (e.g. JICA and the Italian Government) have provided external financial support for aquaculture projects. UNDP and FAO jointly financed the establishment of the Beymelek Mariculture Centre. Between 1991 and 1997 a US\$2.5 million grant fund was provided by the Government of Japan, which was used through the World Bank. A number of studies were conducted by international consultants, including site selection for marine aquaculture; aquaculture legislation; and surveys of inland water resources and marketing opportunities. JICA, as mentioned previously, is supporting the development of turbot culture. Turkey's participation in the EU Sixth Framework Programme (FP6) entered into force in September 2002 and it is believed that this will make a significant contribution to scientific and research activities in the fisheries and aquaculture sector. In addition, Turkey participates in regional projects such as the General Fisheries Commission for the Mediterranean (GFCM), the Information System for Promotion of Aquaculture in the Mediterranean (SIPAM) and EUROFISH, and is a member of international organizations such as the International Commission for the Conservation of Atlantic Tunas (ICCAT).

Extension Services

While research and development continues to be essential in the development of aquaculture, rapid and efficient extension services also have a very important role to play. Such services need the best available expertise because outreach-improved leverage, through networking, collaborative efforts and innovative educational programmes, offers a powerful means for serving the industry.

Various departments and divisions of MARA (the central office of the DG for Production and Development, FRIs and Provincial Agriculture Directorates) are responsible for aquaculture extension. For example, all the FRIs and Provincial Directorates have dissemination and extension units. Unfortunately, they have very limited tools, even lacking classical materials such as booklets, posters and technical notes, while networking is hardly used in extension at all. This service is therefore limited to personal communications, occasional meetings and site visits. The results of research studies are mostly submitted to the DG for Agricultural Research as reports but are hardly ever disseminated and/or published in regional, national or international periodicals. Thus one of the major challenges for sustainable aquaculture will be the development of cost-effective outreach efforts that help to disseminate information, while creating a favourable climate for aquaculture to succeed.

Universities and fisheries research institutes constitute an important source of technical knowledge (consultancy services), which are provided mostly free of charge for aquaculture development and to address specific problems. In addition, local and international consultancy agencies are also available.

Producers Associations

Recognizing the importance of non-governmental producers organizations in decision-making and the adaptation of production activities to the needs of the market, one foundation (Fisheries Foundation of Turkey), three aquaculture associations and one fish promotion society have been established. The fish promotion society and aquaculture associations are purely aquaculture organizations, while the Fisheries Foundation covers the whole fisheries sector, including the processing and marketing subsectors. These associations have only managed to attract marine fish farmers; two of them are for seabass and seabream producers and the other for tuna farmers. Recently, freshwater farmers have also shown an interest in joining producers associations. Cooperatives, although they play an efficient role in fisheries, have not become effectively involved in aquaculture.

Two of these associations are actively involved in legislative and decision-making processes and some R&D activities. In addition, one of the associations is a member of the Federation of European Aquaculture Producers (FEAP). However, much more time and effort is needed to establish efficient partnerships between science and producers associations.

Discussion and Conclusions

Turkey is a large country of about 779 452 square kilometres and a relatively young population approaching 70 million, which is increasing at around two percent per year. In spite of rich and diverse water resources, fisheries production and particularly per capita fish consumption are not at the desired levels. For example, per capita consumption is less than half of the global average and one third of the average EU level. In order to increase per capita consumption to a reference level, for example, of 16 kg (FAO, 2002), Turkey needs to at least double current fisheries production. Despite increasing fishing effort and heavy pressure on stocks, marine and freshwater capture fisheries have almost leveled off at around 500 000 tonnes and under 50 000 tonnes, respectively (Table 1). This leaves aquaculture as the only option to make substantial increases in fisheries production.

Turkey has large and diverse natural resources for aquaculture development. Climates are suitable for growing subtropical and temperate aquatic species. A wide diversity of species can be cultured in fresh, brackish or seawater, employing a variety of production systems. However, the sector is facing the same driving and constraining forces that have propelled or constrained the sector in other countries. The demand for fishery products is growing but competition is strong and consumer needs and expectations are constantly changing. Public scrutiny is on the rise and environmental and social concerns continue to influence the aquaculture sector (Okumuş, 1997; Okumuş, Atasaral and Serezli, 2003).

System, species and product diversity is very limited. There is no practice of traditional extensive aquaculture and the sector is losing half of its potential diversity, due to a lack of shellfish culture. Natural resources are not well managed and some of them are under heavy pressure from pollution and other practices. Coastal aquaculture is highly constrained by other users of the coastal waters, such as tourism, urban development, environmental protection, harbours, etc., and is not expected to show further significant expansion (Okumuş, 2000). Conflicts with other natural resource users in ecologically sensitive waters, and concerns about potential environmental impacts, visual or aesthetic pollution, navigation and food safety, are leading to widespread discussions. Thus conflicts are among the main constraints for development of aquaculture.

Legal and institutional issues also need rapid updating. In terms of the number of institutions and human resources involved in aquaculture, education seems to be well developed;

however, rapid increases in numbers have led to serious doubts about the “quality” of educated manpower. R&D services are lacking in basic research infrastructures, organization and the will for cooperative research projects (even at a national level) to provide a sound scientific basis for the sustainable development of aquaculture. Furthermore, the limited financial sources allocated for R&D are not used efficiently, the needs for further research are not identified objectively, and research findings hardly reach the producers.

In summary, aquaculture in Turkey is currently playing, and can continue to play, an important role at least in maintaining increases in fish production and in meeting the rising demand for fishery products. The major priorities of the sector are access to new sites, economic viability and improved aquaculture governance through enabling policies and social and regulatory frameworks. Thus, the Government of Turkey should increase emphasis not only on production but also on environmental sustainability, food safety and the competitiveness of the industry. Partnerships between science and producers are needed to foster sustainable economic development, the establishment of environmentally-friendly production systems and the creation of new employment opportunities.

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EXPERIENCES IN ESTABLISHING RECIRCULATION SYSTEMS IN BADEN-WÜRTTEMBERG, GERMANY AS A FORM OF SUSTAINABLE AQUACULTURE

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ABSTRACT

Considering that recirculation systems for fish production could be seen as sustainable aquaculture, Baden-Württemberg supported the construction of five new units. After two years of operation three serious disadvantages became obvious: the knowledge of the staff was inadequate; changes in the market situation were high; and operational costs were immense. To reduce errors, staff were therefore trained and informed by scientists and government officials. Furthermore, in order to improve the market situation, new fish species were introduced. However, because of the high operational costs and an unsteady demand it remains uncertain if all farms will survive economically.

The case study of Baden-Württemberg shows that a realistic estimation of the circumstances, especially consumer demand and staff know-how, is essential. Only projects based on a realistic cost-benefit analysis (in this case the relation between the investment and operational costs and the market situation) should receive support from government and/or scientists.

Key words: *Germany, aquaculture, Baden-Württemberg, catfish, cost-benefit analysis, market situation, recirculation systems, sustainable*

Introduction

Recirculation units may provide three advantages in comparison to flow-through systems:

- fish production in these systems could be seen as sustainable aquaculture, compared to the waste load of the effluents from flow-through systems – most recirculation systems have a relatively smaller and more concentrated discharge;
- low water demand enables fish production in regions where water is scarce; and
- fish can be reared year-round in closed (mainly thermo-regulated) systems under controlled conditions with high growth rates.

However, due to the additional equipment needed to treat the water for reuse, recirculation systems have serious disadvantages, namely the need for high capital investment and an appropriate level of know-how. Production levels and/or product value have to be high to cover these high investment and operational costs. Risks are therefore high.

The first recirculation systems in Germany were built 30 years ago. Since that time their popularity has ebbed and flowed. At first most units had inadequate technical standards, and failure was foreseeable. From the early 1980s onwards technical standards improved and more and more units were built (Koops, 1991); however, many of them became bankrupt because of high production costs. Since 2000 a second wave of construction of fish culture recirculation systems has been observed. Simon (2002) recorded 38 systems in existence, a figure estimated to have risen to about 45 by 2005. Whether all these farms have the technology, staff and management needed to succeed in producing high quality fish economically remains to be seen.

Since 2000, five newly built recirculation systems in Baden-Württemberg have received financial support through the Land Baden-Württemberg and the EU. The initial idea was that all the producers supported would cooperate to minimize production costs and prevent competition. European catfish (*Silurus glanis*) were selected as the species to be reared and an annual harvest of 150 tonnes and high market prices were anticipated. The construction company promised to provide adequate training for the investors (all were farmers but none had reared fish before) and to transfer know-how during the initial production years. However, before the first catfish were sold, serious mistakes became obvious.

This paper describes the problems that occurred and how the producers, scientists and administrative officials reacted. Based on this case study, the essential requirements for establishing recirculation systems are provided in the final section of the paper.

The Problems in Baden-Württemberg

The problems encountered concerned management, construction and economics. Most were the result of poor knowledge transfer or unrealistic economic assumptions. By 2005, the expected production of 150 tonnes/year had still not been achieved.

Management problems

In 2002, after one year of operation and before government officials and scientists started to train the farmers, their know-how was inadequate. More than basic knowledge was needed in order to guarantee suitable water quality for fish rearing and product quality.

The quality of the fish stocked into the systems is critically important. The fish stocked need to be free from parasites, diseases and pharmaceutical residues; they also need to be adapted to recirculation systems. However, after months of fattening, a high concentration of malachite green was found in many of the catfish that were originally stocked. The use of this substance is prohibited in the European Union; for this reason the whole stock of most farms in the scheme had to be killed. Other fish that were originally stocked either contained parasites (*Ichthyophthirius multifiliis*) or were infected with the sheatfish iridovirus.

In addition, shortly after operations started, water snakes (*Physella acuta*) were transferred during stocking into four of the systems. These snakes preyed on the filter substrate and reduced the bacteria (*Nitrosomonas* spp. and *Nitrobacter* spp.) that are respectively responsible for nitrification and ammonia removal. The result was an alarming decrease in biological filter efficacy.

Construction problems

Growth rates depend mostly on water temperature; therefore temperature control has many advantages in aquaculture (Summerfelt, Bebak-Williams and Tsukuda, 2001), especially in catfish production (Jungwirth, 1986). In the recirculation systems of Baden-Württemberg temperature is controlled mainly by heating the air of the building. This caused energy costs to be higher than direct heating.

All units were constructed in concrete. This made adjustments (for example to modify the fish tanks for new fish species) difficult.

Economic problems

Two major problems were encountered. On the one hand, as noted above, the forecast annual production of 150 tonnes has still not been reached; on the other hand the expected product market value has not been realized.

All the farmers built the systems in new, well-insulated buildings. Their investment per expected annual production of European catfish ranged from €12 000/tonne to €14 000/tonne. In addition to this high investment level, operational costs were high.

Lower production costs in other European countries (France and the Czech Republic) also reduced market prices for the product during this period.

It was planned to sell all fish live to wholesalers. However, due to an unexpected low consumer demand, only small amounts were ordered.

The Role of Scientists and Government Officials

To support the construction and establishment of recirculation systems in Baden-Württemberg various actions were taken in two steps.

Firstly, after the presentation of a business plan by the construction company (indicating that five producers will cooperate, that staff training and fish marketing will be organized, and that the potential demand for catfish is high), the systems were financially supported by the Land Baden-Württemberg and the European Union (FIFG). Step by step five farms were built but within one and a half years the first problems were becoming obvious.

As a second step, therefore, government officials ordered veterinarians and scientists from the Fisheries Research Station of Baden-Württemberg to train the staff and to help to solve the various problems. These actions started when malachite residues that were above the legal limits were found during a veterinary inspection, following which the eradication of the entire stock was decreed. During this phase the producers complained about poor support from the construction company. The lack of a clear contractual obligation enabled the construction company to cease providing training for the staff and marketing the fish produced.

None of the producers had any experience in running a recirculation system. To help them and to establish recirculating fish farming in Baden-Württemberg, which would be perceived as a form of sustainable aquaculture, veterinarians and fisheries scientists worked as consultants from this point onwards. The aim was to stabilize production and to train the farmers to solve upcoming problems by themselves.

Problem Solving Trials

Solutions for management problems

The need for training and advice for the fish farmers was obvious. Scientists and veterinarians worked as consultants, running separate training courses or providing advice to the producers on-site. In this way solutions for most of the management problems were found.

Nowadays every farmer knows what to do if technical or biological problems become evident (for example, how to stabilize pH or control water quality). Also product quality improved. Normally the taste of catfish is bland but it is susceptible to the development of off-flavour. However, if the fish were held for a few days in cold freshwater, this problem ceased.

To minimize stocking quality problems, on-farm production of fingerlings was supported and controlled through veterinarians, and on the other hand new distributors of young catfish free from diseases and pharmaceutical residues were found. Now, all fingerlings are produced by the farmers themselves.

The snake problem was also solved. Firstly, their numbers were minimized with formaldehyde ($0.03 \text{ ml} \cdot \text{l}^{-1}$). Secondly, in the course of using a new feed in another trial, lower feed fines and better consumption rates were achieved. As the snakes were not only preying

on the filter surface but also consumed feed fines, the use of the new feed reduced their food supply and consequently the snake biomass. An increase in filter efficacy was clearly measurable.

Solutions for construction problems

The best growth rates for catfish are 23-26 °C and this range is therefore obligatory to achieve a high production level. Due to the poor temperature regulation of the systems constructed, two farmers updated them by installing gas heaters. Two others intended to install direct water heating systems but this meant new unplanned investment, which increased production costs further. Additional technical modifications were planned but not realized (a) because the use of concrete in construction made it nearly impossible and (b) in order to spare the farmers further expense.

Solutions for economic problems

A direct solution to reduce the high production costs (caused by high investment costs) was not found.

Various efforts were made to improve product market value or to open new distribution channels. First of all the farmers realized that the whole production could not be sold to wholesalers. Hence, three farmers invested in facilities to slaughter and smoke the fish themselves. Nowadays they sell home-made products as well as live catfish to consumers directly from their farms. Another farmer has a market stall and tries to sell fresh and smoked catfish in various regional markets.

To broaden the product range offered and to substitute for catfish during times of low demand two new species were introduced in two different farms: pike-perch (*Sander lucioperca*) and striped bass hybrids (HSB) (*Morone saxatilis* x *M. chrysops*). Both fish are relatively new in German recirculation systems but prior experience exists (Baer, Zienert and Wedekind, 2001; Wedekind, 2001). It was assumed that risks would be outweighed by higher consumer acceptance (traditional species from the family *Percidae* are popular in southern Germany) and that these fish would obtain higher market values. The fingerlings were obtained from other German recirculation systems and were free from parasites and pharmaceutical residues. All fish were accustomed to dry feed. After 270 days (HSB) or 360 days (pike-perch) of rearing both species showed promising growth rates and an adequate body composition (Table. 1).

Some pike-perch were sold live but most were offered filleted and skinned. In fact, the demand for pike-perch proved to be high and prices were between €11-12/kg for live fish. More fish could be sold than was actually produced. However, there was one significant new problem: the unstable supply of fingerlings prepared for recirculation systems (fed with dry feed, free from parasites and pharmaceutical residues) because only a few suppliers exist.

In contrast, HSB fingerlings are easy to obtain; certified fingerlings from Israel can be imported all year round. So far (2005) around 10 tonnes have been produced and the first fish have been sold, but it is too early to estimate the potential future market for HSB. Despite this, it is recommended to continue production at a low level.

The introduction of pike-perch and HSB were only trials to offer possible alternatives for the future. A lot of questions still exist and no farmers have been advised to change their whole production to these species.

TABLE 1

Growth parameters and body composition of striped bass hybrids and pike-perch

Parameters	Striped bass (hybrids) Mean (min-max)	Pike-perch Mean (min-max)
Initial length (cm)	5.5 (4.3-6.5)	18.3 (14.4-21.2)
Growing period (days)	270	360
Final length (cm)	30.4 (27.5-33.9)	42.6 (40.3-46.1)
Body weight (g)	435.8 (354.3-517.2)	716.2 (598.9-894.6)
FCR*	0.97	1.29
SGR** (%/d)	1.52	0.95
n for body composition	30	20
Eviscerated (%)	85.6 (81.9-87.9)	88.9 (85.4-91.1)
Skinned fillet (%)	35.7 (31.9-39.8)	38.6 (35.5-40.5)
Condition factor (k)	1.55 (1.21-1.70)	0.92 (0.86-0.96)
Intestinal fat (%)	8.4 (6.3-11.7)	4.7 (3.7-5.6)

*FCR: Food Conversion Ratio, **SGR: Specific Growth Rate

Requirements for Establishing Recirculation Systems

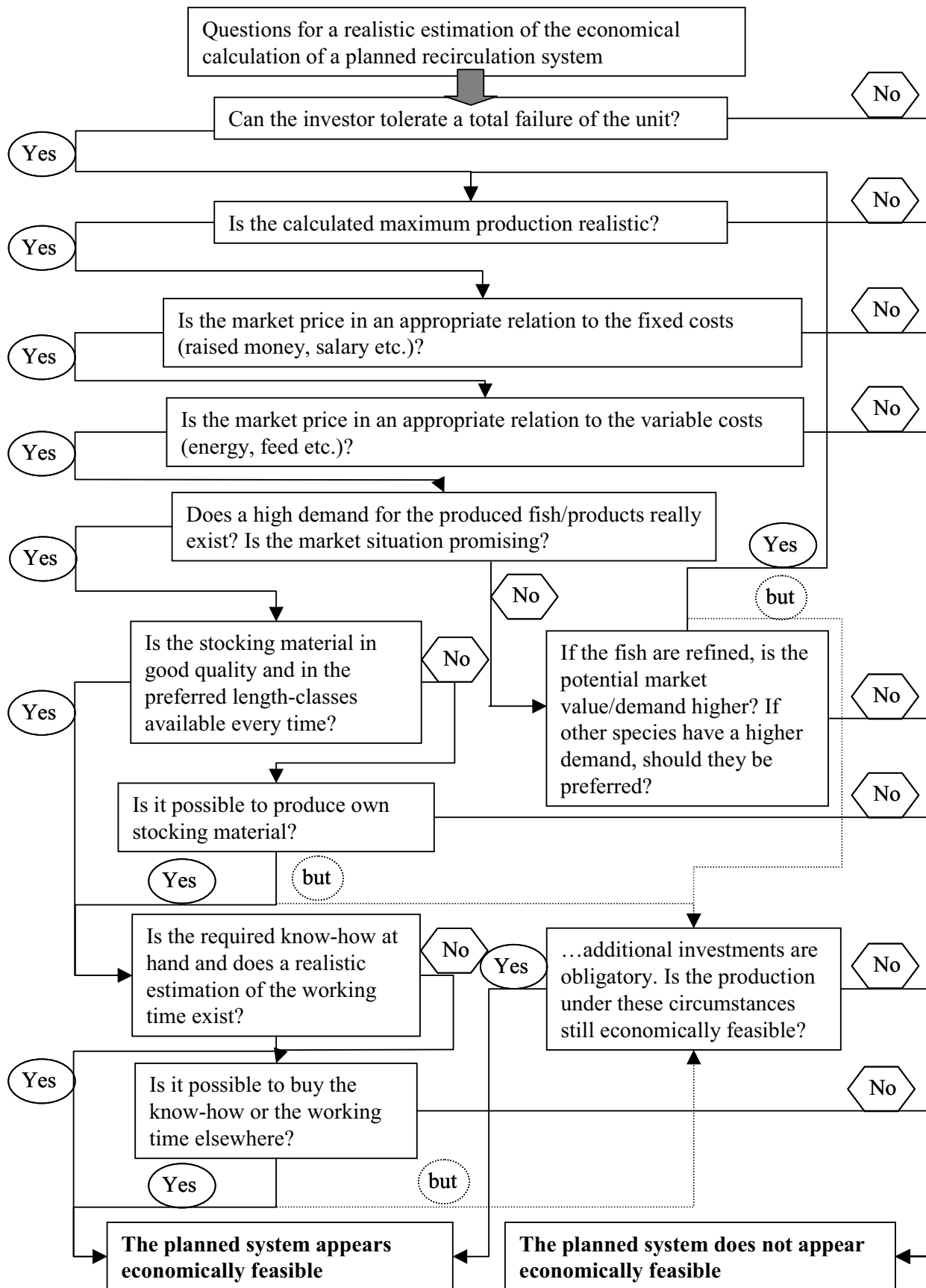
High technical standards for recirculating systems are now available and apparently successful commercial systems exist. Nevertheless, until now, only a few recirculation systems in Germany have survived economically; the majority have gone bankrupt. The case of Baden-Württemberg shows that a realistic estimation of the circumstances is indispensable before building and/or supporting any recirculation system. Many questions need to be answered positively before anyone builds or supports the building of a recirculation system (Figure 1).

If recirculation systems are to receive governmental assistance, an important requirement is a pragmatic estimation of the relationship between investment costs and the calculated maximum production. By 2005, the planned production of 30 tonnes per farm in Baden-Württemberg had still not been reached. As yet, it is uncertain whether the technical conditions for this level of intensification are in fact suitable; because of high operational costs and low consumer demand for the product, no farmer in this scheme has actually had the chance to reach this calculated production. The result is that investment per unit of production has proved much higher than anticipated.

One important factor before building a unit is the evaluation of the relationship between investment costs and variable costs. Needless to say, techniques for adequate fish farming in recirculation systems exist, but production costs need to be as low as possible so that the flexibility to react to adverse marketing problems is there.

FIGURE 1

Questions to evaluate the economic viability of a planned recirculation system



Furthermore, from an economic point of view, recirculation systems must produce a high-value fish species. To obtain a realistic cost-benefit analysis, adequate knowledge of the market situation is required: is there a demand for the various high-value species at all? If not, the chances to amortize the investment are low. The case of Baden-Württemberg presented in this paper provides a good example of the importance of this interrelationship. Farmed trout, whitefish (*Coregonus lavaretus*) and perch from the fisheries of Lake Constance are the dishes of choice locally; few people know catfish. Forecast demand and product value were unrealistically high; at present (2005) only small amounts of catfish are sold and only one farm is making a profit. Because of the high investment and operational costs, product price could not be reduced enough, not even through higher production. This problem is exacerbated because of the much cheaper catfish available from other European countries.

The next important question is to consider whether the whole production from any unit can be sold close to the farm, and live. If not, additional costs for transport and/or slaughter, smoking and packing should be included in the project feasibility study. Sometimes, as in the Baden-Württemberg case, direct marketing is the only way to survive economically, because it is in this sector that the highest net profits can be obtained.

The source and quality of the fingerlings to be stocked also plays an important role in the economic analysis. Two possibilities exist: buying fingerlings from external sources or producing them within the grow-out farm. In both cases it is obvious that the fry or fingerlings have to be free from parasites and pharmaceutical residues. On-farm production reduces the risk of disease outbreaks, and the use of chemicals is under the control of the owner. However, producing fry or fingerlings requires extra culture units, special know-how and extra labour. If the fingerlings have to be bought from other farms, several questions arise including whether the fish are free from parasites, diseases and pharmaceutical residues and whether they are suitable for recirculation systems (e.g. are adapted to dry feed). The case of Baden-Württemberg demonstrates that difficulties arise when unsuitable stocking material is used.

Labour requirements are variable and depend on the species being produced, the end-product and the distribution channel. Consequently labour costs may have a strong influence on product costs; an accurate estimation of this factor is essential for realistic cost-benefit analysis.

Finally, another requirement for establishing a successful recirculating system is well-trained staff. If their experience is inadequate, management failures will be inevitable and the time to reach a high production level will be delayed. The case of Baden-Württemberg shows that some mistakes could have been avoided if the staff had been well-trained. If the know-how is not already at hand, sufficient alternatives to obtain the necessary information are obligatory. Consultants or educated fish farmers have to be paid and, as a consequence, production costs will increase. This point also must not be neglected in cost-benefit analysis.

Conclusions

To summarize, obtaining the advice of scientists and government officials before the construction of any recirculation system is much more important than after construction. This provides a better chance of success. If a unit is already built and difficulties became obvious, reaction is possible. Despite this obvious statement, government officials or scientists are not always given the opportunity of influencing the construction or management of such production units. In such cases, where problems subsequently become apparent and fish farmers ask for advice and staff training, technical modifications or the introduction of new

species may help. However, experience in Germany has shown that these actions are not the magic bullet. Because of unrealistic assumptions, some recirculation systems are beyond remedy before the first fish are sold. Usually, financial problems hamper the farmers from necessary investments. In Baden-Württemberg it is unclear whether all five farms will survive.

This case study has demonstrated that a realistic estimation of the circumstances is indispensable and that projects should be given public support based on realistic cost-benefit analyses. Naturally, not every individual risk can be anticipated and the overall risk level remains high. Therefore only people in a sound financial position, who may be able to bear possible total failure of a recirculation rearing unit for rearing fish should contemplate this type of investment. Finally, a close partnership between scientists and producers is desirable at all stages in any venture.

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GENETIC IMPROVEMENT OF BROODSTOCKS AS A SUSTAINABLE APPROACH FOR SOLVING IMPORTANT PROBLEMS OF CARP PRODUCERS

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ABSTRACT

The main issue that carp producers are facing in Poland is low survival rate of fish stocks caused by various diseases and epizootics. This factor limits the economic and productive effectiveness of carp farming. The objective of selective breeding programmes is the production of resistant stocks with higher non-specific immunity or high tolerance of physiological stress. That goal could be achieved through the combination of two complementary approaches: traditional breeding programmes and studies on the genetic control of immune mechanisms.

The live gene bank at the premises of the Institute of Ichthyobiology and Aquaculture comprises 19 breeding lines with considerable genetic variation in survival rate, forming a strong basis for genetic improvement. Conventional carp breeding programmes involve selection and crossbreeding. Results of investigations on heterosis effect have shown that intraspecific hybridization could be the optimal way for the production of more resistant carp stocks nowadays. The goal of immunogenetic studies is to gain insight into the potential of immune polymorphisms for use as markers in future marker-assisted selection programmes for increased resistance to disease. Studies on several immune related genes like transferrin, MHC genes, iNOS and $\alpha 2M$ revealed considerable polymorphism in common carp lines.

The combination of traditional and molecular-based approaches in carp breeding should result in increased efficacy of selection programmes, reducing the time and cost of producing resistant broodstock.

Key words: *Poland, aquaculture, carp, disease, genetic improvement, immunogenetic, producers, selective breeding*

Introduction

Carp farming in Poland is a highly traditional form of aquaculture. The average annual production of carp is estimated at 20 000 tonnes. The total area of pond surface in Poland is estimated at 51 721 ha, of which over 90 percent is used for carp production (Krüger, 1999). The most common method of production is rearing in earthen ponds. Carp farms may be reasonably large (300-600 ha of pond surface) and they, as well as small, private, family systems with semi-intensive production systems, can afford some investment to increase production efficiency.

Although notable success has been achieved in farming technology, productive traits and growth rate, various bacterial and viral infections are economically important diseases of common carp. Losses can be as high as 90 percent of the stock during the first rearing season, and can reach 30 percent in the second (Pilarczyk, 1998). Thus, heavy losses during the first year have a serious impact on the profitability of carp farming. It could therefore be stated that enhanced survivorship, especially at the fingerling stage, is a requirement for improving production profitability in these pond systems.

The objective of selective breeding programmes is the production of resistant stocks with higher non-specific immunity or high tolerance of physiological stress. That goal could be

achieved through the combination of two complementary approaches: traditional breeding programmes and the implementation of marker-assisted selection through studies on the genetic control of immune mechanisms.

The most effective means of performing a selective breeding programme is through line selection. The Institute of Ichthyobiology and Aquaculture of the Polish Academy of Sciences in Gołysz possesses a live gene bank that contains 19 different carp lines of different origins. This live gene bank comprises several Polish breeding lines as well as carps originating from Hungary, the Ukraine, France, Yugoslavia, Lithuania and Israel, forming a strong basis for genetic selection.

Traditional Selective Breeding Approach

Conducting selective breeding programmes comprise two basic elements: selection and crossbreeding. The main goal is to provide carp producers with high quality stocking material – either hatchlings or broodstocks. Breeding principles have traditionally been based upon those of the “Polish school”, which aim at mass selection, giving priority to growth rate, body shape, scale pattern and resistance to pathogens, in that order of importance.

The established practice of individual tagging allows fast identification of the individual, generation and sex of the particular breeder in each carp line. For the first three years, the pre-selected individuals are reared in culture conditions close to those applied in commercial carp farms. Thus artificial selection applied to the economically desirable characteristics is performed in an environment typical of the production farms. The following generations in each line are obtained through regular mating between close relatives. This is aimed mainly at the fixation of desirable traits and the production of a certain level of uniformity within lines. As a consequence of inbreeding, a certain level of reduction of fitness was observed in some carp lines. To overcome the effects of inbreeding, crossings between various lines to produce superior crossbreds is routinely applied.

Investigations since the early 1950s have been focused on defining the crosses providing the highest heterosis and testing the combining ability of the different carp lines. Because of environmental year-to-year variability, the performance of crosses is estimated in comparison with progeny of the parental lines, which are the same age and derived from the same breeders. During the first growing season the crosses and parental lines are stocked in separate uniform ponds in replicates. In the subsequent rearing seasons, randomly chosen tagged individuals from parental lines and crosses under test are kept in a communal pond, in order to reduce environmental variance. Survival rate and performance is estimated for each rearing season separately. All this allows an estimate of the amount of heterosis obtained and a choice between lines that are giving the best cross to be made.

Not all crosses have shown positive heterosis. Positive heterosis measured on two characters – survival and growth rate – was recorded for every second cross, on average. Table 1 presents the average values of useful heterosis for these traits, as observed during the several tests.

The effect of heterosis is most pronounced at the earliest stages of development, and mainly in such a character as survival rate. During the following rearing seasons the amount of heterosis decreases. In extreme conditions, such as infectious outbreaks, the observed value of heterosis is usually much higher.

TABLE 1

The relative amount of heterosis for two characters – survival and weight gain – observed in F1 common carp, measured as the deviation from the mid parent values and from the best performing parent population (*in italic bold*)

Seasons	Survival (%)	Weight (%)
I Production season	140-160	125-135
	<i>125-135</i>	<i>105-115</i>
I Winter	130-150	
	<i>110-120</i>	
II Production season	110-120	110-120
	<i>110-120</i>	<i>105-115</i>
II Winter	100-110	
	<i>100-105</i>	
III Production season	105-115	110-125
	<i>100-105</i>	<i>110-120</i>
3-year period	250-350	125-135
	<i>200-300</i>	<i>110-120</i>

An illustration of heterosis observed in crosses between pairs of common carp lines W and T is given in Figure 1. Two crosses (WxT and TxW), as well as their parent lines (TxT and WxW), were compared for survivorship and growth rate. The values of survivorship of the two parent lines were similar, decreasing systematically by the end of the II production season. Mortality observed in the WxT cross was highest during the first production season. The TxW cross, additionally showed high mortality during the second production season. High mortalities at the beginning of the II season in the TxW cross and the parent lines were caused by a spring viraemia outbreak. The difference between the two crosses in the relative amount of heterosis may be caused by maternal effect. Figure 2 presents the heterosis observed for growth rate.

The results of other experiments have shown that crosses between common carp lines are particularly suited for intensive production systems. Heterosis is especially pronounced in a suboptimal environment, at higher stocking densities and in poor feeding conditions. Our investigations on combining ability and heterosis in common carp resulted in knowledge about the best line combinations providing crosses with improved survival, growth rate and food conversion efficiency.

FIGURE 1

An illustration of heterosis for survival rate observed in crosses between two lines of common carp, T and W

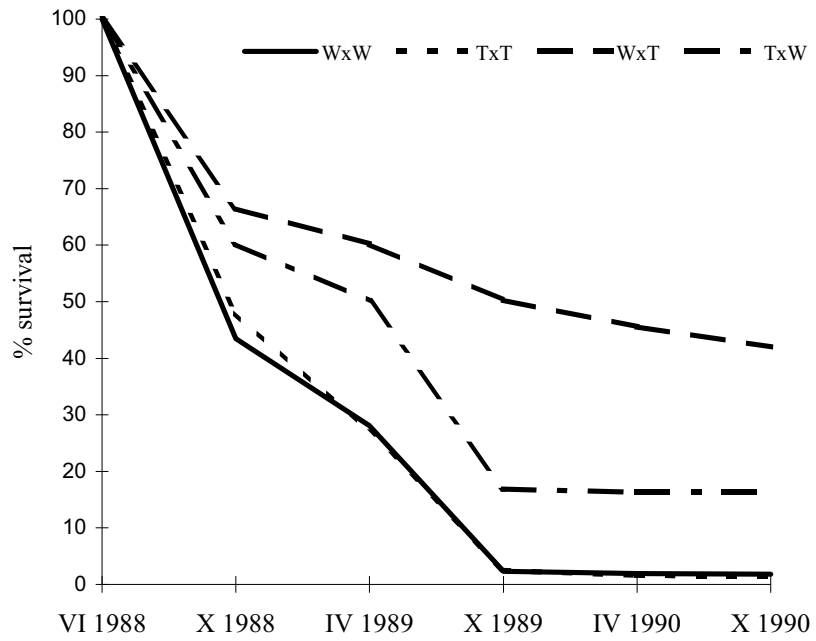
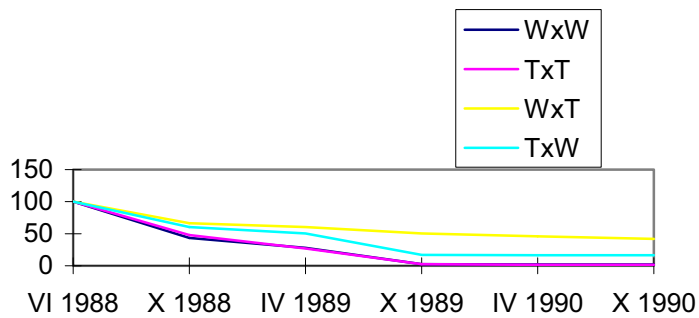


FIGURE 2

An illustration of heterosis for growth rate observed in crosses between two lines of common carp, T and W



Variations in Natural Resistance and Immune Polymorphism

Regular observation of the survival of carp breeding lines of different geographical origins over the period 1981 to 1996 showed different survival rates in distinct lines, raised under pond conditions (Table 2). The differences shown may depend on differences in resistance to a specific pathogen. Ichthyopathological studies have shown notable differences in the level of swim-bladder infection and tapeworm infestation among common carp lines (Pilarczyk, 1998). It has been thoroughly established that the ability of fish to resist infection by a wide range of pathogens is influenced by genetic factors.

TABLE 2
The average survival rate of the carp lines after the first rearing season (1981-1996)

Carp breeding lines (symbol)	Survival
Polish (K)	16.0 ± 20.9
Polish (R2)	17.9 ± 19.8
Israeli (DOR-70)	30.9 ± 8.7
Hungarian (R7)	39.6 ± 11.8
Hungarian (R8)	35.3 ± 11.9
Hungarian (R0)	33.9 ± 12.7
German (N)	67.9 ± 19.8
Ukraine (Ur)	47.9 ± 8.9

Source: Pilarczyk (1998)

Preliminary investigations on the number of immune related genes in carp lines constituting the live gene bank indicated the presence of a considerable amount of polymorphism. Studies have showed the presence of at least ten MHC class II beta alleles in genomic material isolated from four different carp lines (Rakus *et al.* 2003). For the main iron binding protein – transferrin – at least five alleles were found in eight carp lines (Irnazarow and Bialowas, 1995a; 1995b). Polymorphism was detected for the iNOS genes as well, showing at least eight haplotypes for the two region of this gene (Kachamakova *et al.*, 2004). Sequence analysis of alpha 2-macroglobulin of common carp cDNA has revealed the presence of at least three coding sequences for this protein (Onara *et al.*, 2003). The apparent involvement of these genes in the immune response further justifies their usefulness as candidate genes (markers) for disease resistance.

Infectious Disease Models Allow for Association Studies

Survival is under the influence of many environmental parameters, however, and special effort needs to be paid to differentiate between environmental and genetic effects. At the Institute of Ichthyobiology and Aquaculture of the Polish Academy of Sciences we use disease models to detect putative correlations between differences in survival rate under pond conditions and differences in resistance to a specific pathogen under laboratory

circumstances, thereby minimising environmental influences. Two disease models are applied – the blood parasite *Trypanoplasma borreli* and the bacterium *Aeromonas hydrophila* that is commonly associated with epizootic ulcerative syndrome. The possibility of infecting animals with known numbers of parasites using syringe-passage, the possibility of carefully monitoring infection and the possibilities to manipulate, in a controlled manner, infection through manipulation of injection route, dose or temperature allow for careful experimentation on fish. Easy access to infected fish allows for expression studies on immune related genes and tracing the immunological parameters, thus providing deeper insight into the functional meaning of the genetic variation observed. Figure 3 presents results on challenges to two carp lines – Polish R2 and Israeli Dor-70 – with the blood parasite *T. borreli*, showing statistically significant differences in parasitaemia between these two lines.

FIGURE 3
Parasitaemia following i.m. infection of R2 (Polish) and D (Israeli Dor-70) carps ($n = 15$ in each group) with *Trypanoplasma borreli*. Vertical bars denote 0.95 confidence interval

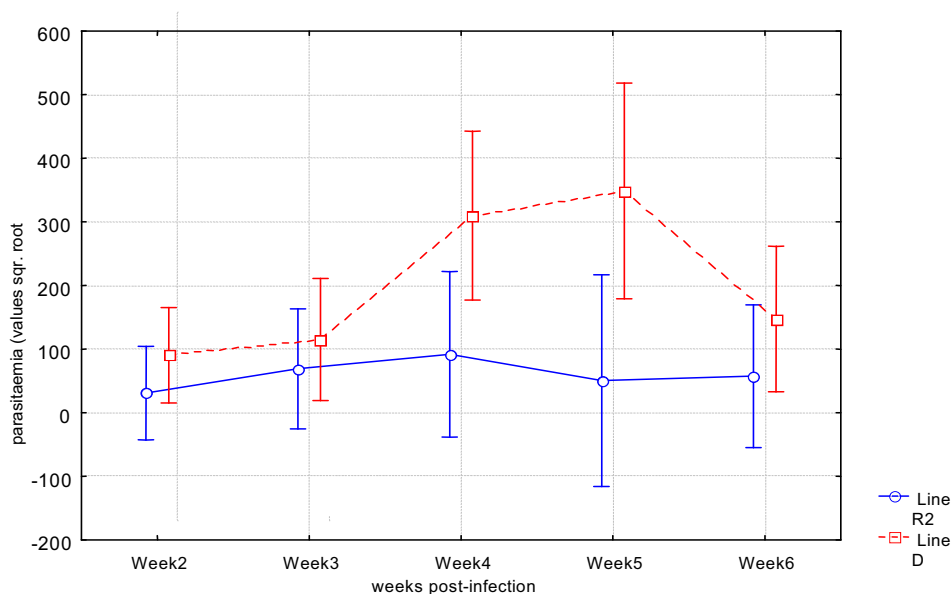
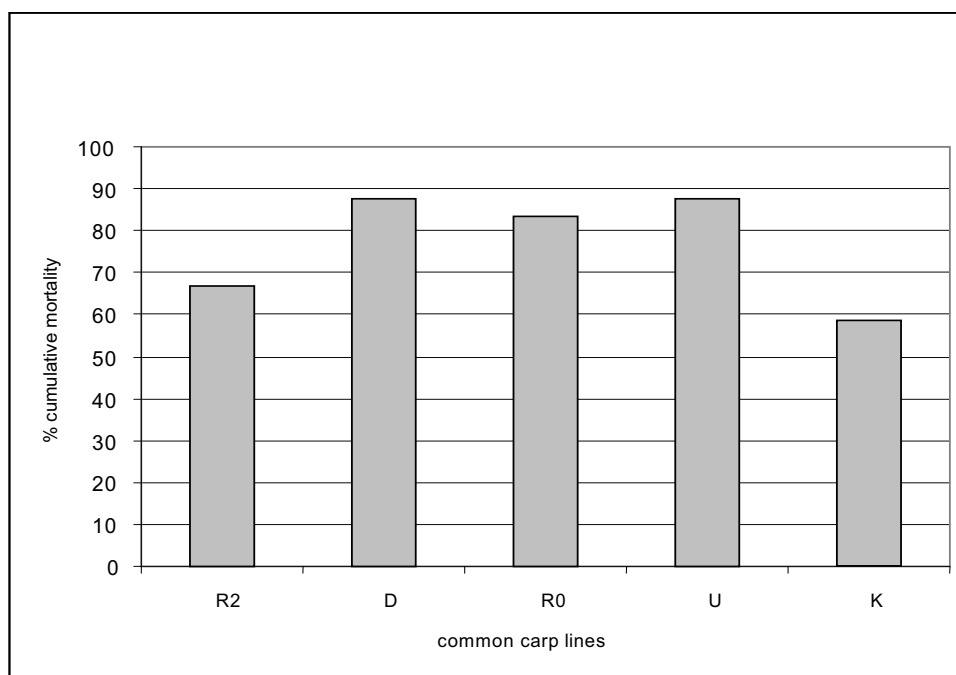


Figure 4 shows an example of cumulative specific mortality between five common carp lines challenged with *A. hydrophila*. The lines used for the challenge experiment were Polish R2 and K, Israeli D (Dor 70), Ukrainian U and Hungarian R0, which are commonly used in aquaculture practice in Poland. The fish were all tested in the same test facility at 20 °C. Carps from different lines were randomly distributed among tanks and mortality was recorded during the first 12 days post-infection.

Challenge experiments are aimed at typing carp lines naturally resistant or susceptible to a particular pathogen. The line selection is based on a series of challenge tests to minimize test-to-test variation in outcome. Further experiments will be focused on verifying the heritable component of observed differences between carp lines. To this end the following generation derived from crosses between two divergent lines will be backcrossed to one or both parental lines, or crossed *inter se* to produce an F2 generation.

FIGURE 4

Cumulative mortalities in five common carp lines – R2 and K (Polish), D (Israeli Dor-70, U (Ukrainian) and R0 (Hungarian), ($n = 25$ in each line), challenged with *Aeromonas hydrophila* by i.p. injection



Conclusions

So far, performed challenge tests have provided evidence that suggests that genetic differences may exist between carp lines in susceptibility to particular pathogens.

The results of challenge experiments using two types of pathogen, *T. borreli* and *A. hydrophila*, indicate that the differential resistance to a specific pathogen of common carp lines is not necessarily correlated with the survival rate observed under pond conditions. Nevertheless, obtained data serves as a basis to search for association of the desirable character (disease resistance to a specific pathogen) with molecular polymorphism at each immune related gene under the test. Correlation of certain alleles with high or low survival and disease resistance, suggesting selective (dis)advantage, will be examined in backcrosses using PCR typing for detection of alleles in large numbers of progeny. The main goal will be to clarify the genetic base of the number of immune related genes of carp and its immunobiological function in relation to fish health and thus performance.

If the identification is unambiguous, the results will find direct application *via* the provision to fish farmers of “commercial” carp lines, derived from parental fish bearing advantageous alleles. This is expected to lead to an optimization of traditional semi-intensive farming practices.

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COOPERATE TO COMPETE: FISHERY PRODUCT CHAINS AND THE ROLE OF SCIENCE

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ABSTRACT

In this era of globalization and internationalization of trade in fisheries products, no fisheries or aquaculture enterprise is able to keep track of and address by itself all of the rapidly changing consumer demands in terms of product quality, food safety, traceability, environmental friendliness of production and humane treatment of the species involved. Primary producers associations and cooperatives can fill part of the gaps in information required by fisheries and aquaculture enterprises, increase their negotiation power and provide advice on technical and marketing aspects. Actions and decisions taken by the other stages in the fishery marketing channel affect the final product (quality, safety, content, form, package, price, etc.) and thus consumer demand. This makes coordination with these other stages necessary. The establishment of fishery product chains therefore might be an answer to increasing consumer demands. Science has shown to be essential in the development and maintenance of fishery product chains (e.g. in Ireland, Norway, Netherlands and Viet Nam). On the basis of findings from various fishery sector chain development projects one can argue that science plays a catalytic role in bringing channel partners together, establishing public-private partnerships, providing mechanisms and methodologies for chain coordination and increasing the up-to-date technical know-how of chain partners.

Key words: *Ireland, Netherlands, Norway, Viet Nam, fisheries, fishery product chains, public-private partnerships, role of science, vertical cooperation*

Introduction

Net export revenues from fish exports earned by developing countries reached US\$17.7 billion in 2001, an amount larger than for any other traded food commodity, including rice, cocoa, tea or coffee (FAO, 2004). To be able to compete in such a highly international business and trade environment it is recognized that collaboration nationally as well as internationally is required. Primary level producers, such as fisherfolk and aquaculturists are easily squeezed in an environment where up-to-date information on prices, products, quality standards, policies and regulations is vital for their success and survival. No fisheries or aquaculture enterprise is able to keep track of and address the rapidly changing consumer demands in terms of quality, food safety, traceability, environmental friendliness of production, and humane treatment of the species used in the aquaculture, on its own. Large international players, such as the aquafeed and chemical industries on the supply side and the retail conglomerates on the demand side, have access to the information that is required to address these emerging consumer demands. Primary producers associations and cooperatives can fill part of the gaps in the availability of information required by fisheries and aquaculture enterprises, can assist them to increase their negotiation power and provide advice on technical issues. However, they generally cannot influence (let alone decide) on processes that take place elsewhere in the fishery product marketing channel. Actions and decisions taken by the other stages in the channel affect the final product (quality, safety, content, form, package, price, etc.) and thus consumer demand.

Apart from those situations where fisheries and aquaculture enterprises are part of a fully-integrated enterprise that manages and controls the complete production and marketing process, it is always necessary for individual enterprises, associations and cooperatives to take into account and coordinate with others in the channel. The same is true for the other stages in the channel; “today the watchword is not divide and conquer but cooperate to compete” (Ford and Saren, 2001). Through strengthening the relationships in the fisheries production/marketing channel, increasing coordination and cooperation, a chain can be developed, which can improve the total performance of the channel (Van Anrooy, 2003a).

Fishery Product Chains and their Purpose

One can define a fishery product chain as a series of successive economic activities, which are carried out deliberately by enterprises active in the fishery sector to serve each other, and that result in fishery products or services that comply with the demands of the final consumers. A chain for fishery products might consist of: fish feed industry – aquaculturist – middleperson – fish processor – fish exporter – importer – wholesaler – retailer; however, other types of chains (different or shorter) are possible as well. Therefore, a less demanding general definition of a chain is the cooperation bond between two or more companies that are active in successive stages in the business column (Borgstein *et al.*, 1997). The actors appearing as participants in the chain are connected by precedence relationships, mainly imposed by physical dependencies in manufacturing processes (Beers, Beulens and van Dalen, 1998).

The overall objective for the establishment of a fishery product chain is to obtain a larger profit for the participants in this cooperation. Other subordinate objectives may be, for instance, to increase market share, enhance the image of the product, enable technical innovations, reduce risks, improve product quality, increase the ability to obtain finance, gain competitive advantage or market power and decrease the effects of market failures. It is generally expected that participants in the chain cooperation have a better market performance. Prahalad (1993) recognized that performance is commonly measured by profitability and identified as leading to greater performance and profitability: more efficient management of quality, costs, cycle time, logistics and productivity. Various projects and studies that assessed chain performance have confirmed that partnerships in the form of a chain are associated with higher levels of performance, e.g. chains for fresh fruit, salads and vegetables in the United Kingdom (Duffy, 2002), fishery products in Viet Nam (Van Anrooy, 2003b), beef in Spain (Briz, Penna and De Felipe, 2002) and pigs in Australia (Gall and Schroder, 2002).

The development of fishery and aquaculture product chains is important in the light of current developments such as:

- increasing consumer demands on aspects such as healthiness, food safety, HACCP, environmentally friendly production processes, biodiversity maintenance, animal welfare, traceability and compliance with international labour laws;
- rapid technological developments in the fields of products, production processes (e.g. Individual Quick Frozen) and information exchange (e.g. new information and telecommunication technologies);
- increasing capital needs in production (recirculation and waste treatment systems, flow freezers and IQF, HACCP) and product research and development;
- increasing diversification in fisheries and aquaculture products and species through value addition and the use of exotic species in aquaculture;
- increasing international competition caused by satisfied and/or only slowly increasing markets and trade liberalization;

- high risks (e.g. in view of possible detentions of products in the EU or the USA related to, for instance, chloramphenicols); and
- high mutual dependency (Van Anrooy, 2003b), related to the specific characteristics of the fisheries and aquaculture products, such as perishability; variation in quality and quantity caused by seasonality; handling and care; variation in production process speed; complementariness of the inputs; and the intrinsic quality of the fresh products, which is highest at the moment of harvest (Den Ouden *et al.*, 1996).

Chain Science

Chain science is the theoretical domain related to the analysis of chains (based upon Omta, Trienekens and Beers, 2001). It concentrates on the behavioural and social aspects of the organization and governance of exchange relationships, the nature of choices being made, the incentives and constraints, the basis and the use of power, and the nature of interaction and communication (Omta, Trienekens and Beers, 2002). Chain science can contribute to the development and management of fisheries and aquaculture product chains by identifying the critical factors for successful design and control mechanisms of chains, determining the most adequate operation and information systems for chains in the sector, and providing guidance on inter-organizational management that is not limited by national borders and which has access to a wide variety of technologies.

The Role of Science in Fishery Product Chain Development: some Examples

In the Netherlands during the mid-1990s the Stichting Agro-Keten Kennis (AKK) supported various initiatives that addressed the fishery product chain. One of the projects, entitled “Growth chances for cultured fish”¹⁸ emphasized that, due to the widespread and small-scale approaches used by the Dutch aquaculture sector, producers could not reap the full benefits of the increasing demand for aquaculture products. It was expected that chain-wise production and market development would overcome these constraints. Better collaboration between research and the private sector was seen as the key to success. The project developed a strategy to support the fishery product chain knowledge infrastructure and increase the collaboration between the various stages participating in the chain. The project, which focused on catfish and eels, was quite successful.

A second project, implemented during the same period, was entitled “PROVIS: fresh chain products during the whole year”¹⁹. This project focused on improving the fishery product chain to allow continuous supply of the shelves in retail outlets, install total quality management and better address consumer demands. A third project, titled “Fish instantly: innovation in fish”²⁰ addressed the gap between supply and consumer demand. It tried to support, through a chain approach, the continuous demands for innovation originating from the market. In all three above mentioned projects the academic world and government research institutions were key partners of the private sector in the development and management of the fishery product chains.

In Viet Nam the collaboration between various stages in the fishery product marketing channel was investigated by FAO in 2001 to 2002 under a project titled “Fisheries marketing

¹⁸ Groeikansen voor Kweekvis

¹⁹ PROVIS: Ketenversproducten, het hele jaar door

²⁰ Vis a la Minute: innovatie in vis

and credit in Viet Nam”. Respondents in a country-wide fishery sector survey among fisherfolk, aquaculturists, wholesalers, processors and retailers, emphasized the benefits of long term relationships with their business partners. They generally considered the improvement in their business relationship and the increased access to market information as major reasons for being involved in long-term collaborative relationships. A clear importance was also given to the possibilities of cost reduction through collaboration with others in the channel. The survey showed that although fisherfolk and aquaculturists were highly interested in fishery product chain development they were not very active in promoting collaboration in this direction. There is a tendency towards waiting for others to take the initiative. Generally they consider that the Ministry of Fisheries, together with the research institutes under it, should take a leading role in the development of chains. Fisherfolk and aquaculturists also considered wholesalers and the Viet Nam Association of Seafood Exporters and Processors (VASEP) to be better equipped to facilitate the process of chain development.

In Norway, the National Institute of Nutrition and Seafood Research (NIFES) conducts research covering the entire food chain from feed resources to safe and healthy seafood for consumers: from “fjord to fork”. The research includes projects on fish feeds, fish nutrition, fish health, fish quality, seafood safety and the beneficial effects of seafood consumption on human health. The chain approach is used by NIFES to address mainly health and nutrition issues. Other players in Norway that promote chain strengthening and development in the fishery sector include the Foundation for Scientific and Industrial Research at the Norwegian Institute of Technology (SINTEF) in collaboration with the academic world (e.g. the Norwegian University of Science and Technology, NTNU). They aim to increase collaboration between fisherfolk and aquaculturists and the other actors in the production channel, involving the relevant producers associations. Most projects address specific problems in the channel related to technology, processing and marketing issues, and involve the academic world.

Another example worth mentioning is one that addresses the linkages between science and the development of fishery product chains through a government agency with responsibility for developing the sea fishing and aquaculture industries. In Ireland, the Irish Sea Fisheries Board²¹ (BIM) uses a chain approach in its Quality Seafood Programme. This programme is used as the vehicle for communicating quality achievements in the chain from wholesale to consumer level. BIM provides marketing solutions that assist its member seafood companies to identify and secure market advantage for Irish seafood products in the domestic and export markets. It aims to provide commercially relevant services to its members at all stages in the fishery product chain, by making use of and collaborating technically and financially with other government institutes, private enterprises, the EU and national academic institutions.

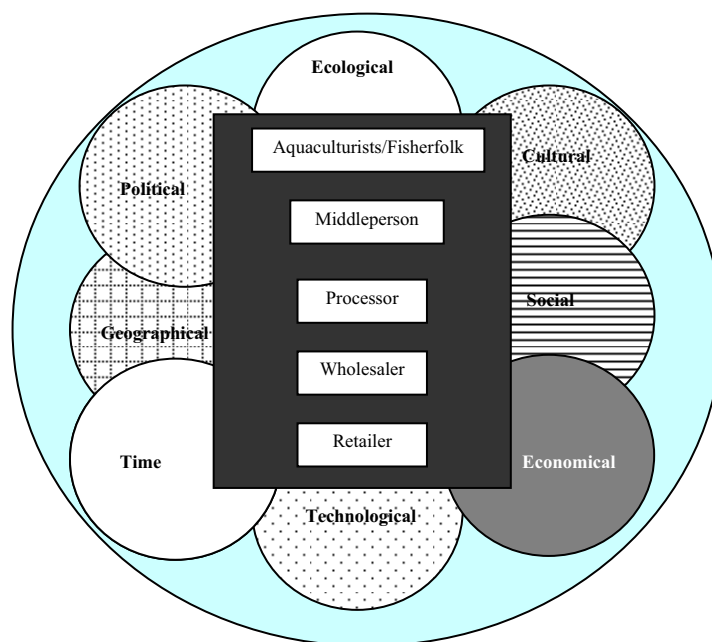
Contribution of Science to Fishery Product Chain Development and Management

Apart from the earlier discussed role that chain science can play in the establishment of fishery product chains (through chain science and as initiator of fishery chains) it might be useful to provide a simple overview of the overall environment in which fishery product chains are functioning. Figure 1 shows a fishery product chain with the actors at the various stages and the areas in which it is connected with the wider environment. These connections can be considered as an integrated part of the wider society (e.g. tax is derived from the sector and used for social services, infrastructure, etc.).

²¹ Bord Iascaigh Mhara

FIGURE 1

An example of a fishery product marketing chain with its wider environment



Current fishery product chains appear to be active particularly with respect to socio-economic and technological issues. Marketing and trade, addressing changing consumer demands and development of appropriate technologies are areas in which chains are already clearly showing their value. Science is playing a role in many fishery product chain initiatives by contributing to the processes within the chain, such as establishing collaboration between government and research institutions and the private sector, gathering and analyzing information, providing technical advice and exchanging up-to-date knowledge.

So far, the role of science seems relatively limited with regard to the political and ecological areas that fishery product chains are moving in; these may be areas in which science can strengthen fishery product chains even further, through the already existing ties that scientific institutions generally have with the government.

Opportunities that Partnerships between Science and Producers Associations Offer in Relation to the Development and Management of Fishery Product Chains

In the fisheries sector it is likely that most fishery product chains include a producers association (or, for example, a product board, cooperative, producers organization, cluster management group, solidarity group) because individual producers are generally not large enough (in terms of quantity produced and manpower availability) to be attractive partners for the other parties/stages in a chain cooperation (such as retailers and processors).

On the one hand, a producers association provides the advantage of enabling scientific institutions to do research on more aquaculture farms and fishing vessels, to allow comparison and statistically relevant results. On the other hand, a producers association has generally greater financial flexibility than individuals to fund scientific research on chain issues. Partnerships with producers associations enable chain scientists to test their theoretical models and ideas in practice and obtain new insights on how to improve them further. Producers associations have the advantage that they have direct contact with the primary

producers and play a pivotal role in transferring knowledge, providing services, initiating and taking part in discussions on policy issues and representing the concerns of their members (the primary producers); these make producers associations interesting partners for science.

Producers associations can obtain access to the latest insights and developments coming from scientific research, through the establishment and maintenance of partnerships with scientific institutions. These partnerships can increase the response from science and research to issues (e.g. on the policy and management side) that enable and contribute to the development of effective fishery product chains. Moreover, a number of scientific institutions are involved in chain science, and the capacity developed within and by these institutions can be of key importance in the development and management of fisheries and aquaculture product chains.

Collaboration between science and producers associations in support of the establishment and management of chains engenders mutual benefits, as is the case in many public-private partnerships. In this respect it is worth mentioning the opportunities that exist in the fields of novel capacity development and information exchange methodologies and mechanisms that collaboration would contribute to. These include:

- possibilities to capitalize on the unique strengths of both sides;
- cost savings that can be achieved through collaboration;
- increased access to financial resources and opportunities for investment;
- enhanced chances for exchange of ideas and experiences; and, last but not least,
- greater opportunities to generate profits.

The latter, being the main objective for becoming engaged in chain collaboration, is equally valid as an objective for building science-producers association partnerships in support of fishery product chains.

The European Inland Fisheries Advisory Committee (EIFAC), along with other Regional Fisheries Bodies and inter-governmental organizations, could probably play a facilitating role in strengthening the linkages between science and producers associations, as is occurring during the symposium at which this paper is being presented. This meeting has demonstrated clear opportunities for collaboration; however, as far as fishery product chain collaboration is concerned, these benefits are not fully understood (yet) and exploited to the extent possible. The collection and dissemination of success stories on collaboration between science and producers associations in fishery product chains might be a good way to highlight the opportunities such collaboration offers to the partners involved.

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The Symposium on Aquaculture Development – Partnership between Science and Producer Associations was held in Wierzba, Poland, from 26 May to 29 May 2004 in concomitance with the Twenty-third Session of the European Inland Fisheries Advisory Commission. The Symposium was attended by 72 participants from 23 countries. Five invited papers, 37 experience papers and three posters were presented. The Symposium considered existing and possible partnerships and collaboration between aquaculture producers and scientists, government officials and other stakeholders. The Symposium further addressed opportunities and needs of aquaculture producer associations, and identified measures and recommendations to strengthen participation, activities and positions of aquaculture associations in the management and development of the aquaculture sector in Europe. In addition to the report of the Symposium, this document contains the Symposium proceedings which commence with a review of the key elements from five invited papers presented by representatives of the European Commission, the Federation of European Aquaculture Producers, the European Aquaculture Society, Aquaculture Technology and Training and the Network of Aquaculture Centres in Asia-Pacific. Fourteen selected experience papers, presented by authors from France, Germany, Hungary, Italy, the Netherlands, Poland, Romania, the Russian Federation, Turkey and the United Kingdom of Great Britain and Northern Ireland, cover, *inter alia*, aquaculture, conservation, cooperation, economic transition, ecotourism, education, fisheries, management, planning, partnerships, policy, producers associations, product chains, recirculation, risks, stakeholder participation, sustainability and the role of science.

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