International Council for the Exploration of the Sea

Council Meeting C.M.1993/F.13
Mariculture Committee
Ref: E

Aquaculture and Environmental Regulations in EC Countries: A Report on the outcome of a Workshop held in Hamburg 23-25 November 1992

by

Harald Rosenthal*
Department of Fishery Biology
Insitute for Marine Science
University of Kiel
Federal Republic of Germany

Introduction

The Workshop on "Fish Farm Effluents and their Control in EC Countries" was held in Hamburg, Germany, November 23 to 25, 1992. The Workshop was jointly organized by the Department of Fishery Biology, Institute for Marine Science, University of Kiel, the Ahrensburg Station of the Bundesforschungsanstalt für Fischerei and the Rijksinstituut vor Visserij Onderzoek, Ijmuiden, The Netherlands.

With the common market approaching a new phase in 1993, the question arose whether there is a need to harmonise the regulatory efforts within EC countries and to standardize the recommended control procedures. The Workshop addressed key problem areas related to these issues in modern fish farming.

Problems associated with fish farm effluents are not a new concern to practioners, scientists and administrators involved in the management and regulation of the aquaculture industry. A number of organisations - national and international - have dealt with the various environmental aspects of aquaculture. In freshwater, the Working Party of EIFAC (European Inland Fisheries Advisory Commission of FAO) has addressed many pertinent aspects on discharge characteristics of land-based farming systems and their environmental impact. In the marine environment, the Working Group on Environmental Impact of Mariculture of ICES (International Council for the Exploration of the Sea) has delineated the dimension of the ecological problems associated with cage farming in coastal waters and identified a course of action which member countries could use to minimize impacts. In 1991 GESAMP (Group of Experts on Scientific Advice on Marine Pollution) established a Working Group on environmental aspects of coastal aquaculture in developing countries. It is therefore timely to address the pertinent ecological issues on an European level.

---

* This document is based on the Report presented to the Commission of the European Communities. The Report was prepared jointly by the an Editorial Committee with the following additional membership: Volker Hilge (Ahrensburg, FRG), Andries Kamstra (IJmuiden, The Netherlands), Edward A. Black (Victoria, BC., Canada), Peter Burbridge (Comrie, Scotland), Ian Davies (Aberdeen, Scotland), Jaqueline Doyle (Dublin, Ireland), Richard Gowen (Belfast, Northern Ireland), David Alderman (England, Rapporteur), Mike Poxton (Edinburgh, Scotland, Rapporteur), William S. Silvert (Dartmouth, N.S. Canada, Rapporteur).

The workshop received overviews of the environmental loading and ecological effects of aquaculture effluents and the approaches which could be employed to minimize both the output of waste and its impact on the environment. The role played by effective site selection and resource allocation in this process was stressed. Papers were presented describing the regulatory structures for the control of aquaculture effluents in 19 countries. Position papers were provided by the EC, EIFAC-FAO, FES, and the Federation of Greek Maricultures. Thirty two technical posters were also presented.

Overview Contributions

The overviews included the following subjects: (a) *Pollution Loads Derived from Aquaculture: Land-based and Water-based Systems* (Hans Ackefors and Magnus Enell); (b) *Environmental Impacts: Negative and Positive Aspects* (Harald Rosenthal); (c) *Minimizing Inputs (Feed Optimization): Eutrophication "Not on the Menu"* (Reid Hole); (d) *Minimizing Outputs (Treatment)* (Simon J. Cripps); (e) *An Ecological Approach to Minimizing the Impact of Aquaculture on the Natural Environment* (Richard Gowen); (f) *Integrated Farming Systems with Special Reference to Lagoonal Areas* (Ettore Grimaldi and Gino Ravagnan); (g) *Monitoring for Farm Management: Freshwater, land-based systems* (Yves Moutounet); (h) *Monitoring Ecological Change Associated with Marine Fish Farming* (Richard Gowen); (i) *Site Selection and Regulation Issues for Trout and Carp Farming* (Mathias von Lukowicz); (k) *Strategies for Aquaculture Site Selection in Coastal Areas* (Edward A. Black);

Position Papers

A total of five papers were presented at the Conference, representing (a) the view of intergovernmental organisations such as the *"Commission of the European Communities"*, the *"European Inland Fisheries Advisory Commission of FAO"* (including the analysis of a draft survey on national legislation of effluent discharges from fish farms in EIFAC countries), and (b) regional and local organisations of the industry such as the *"Fédération Européenne de la Salmoniculture"* with most of its members from northern European countries and the *"Federation of Greek Maricultures"* with interests mainly in the Mediterenean area. The full text of these Position Papers can be found in Annex 1 of this document.

Dr. Piccioli provided an overall outline of the general policy of the EC legislation, aiming at restoring and protecting the environment through a number of directives through which governments collaborate. Some of these directives (Council directives 78/659, 79/923, are partly applicable to several aspects of regulating fish farm effluent and are described. He also stressed that the environment is not a field of Community exclusive competence and Community action may not necessarily include legislative initatives but may be supporting the coordination of national actions, or specific programmes of common interest which otherwise would not be tackled appropriately or in time.

Dr. Barg stressed the importance of regional studies on environmental assessment and management of aquaculture development and outlined the programmes in which FAO is presently involved. The options for environmental management of aquaculture as viewed by EIFAC are also outlined. These include environmental management issues at farm level, socio-economic aspects and public awareness issues to enhance the understanding of interactions between aquaculture and the environment, and aspects of improved legislation governing aquaculture development.

Dr. Warrer-Hansen expressed the view of the aquaculture industry on environmental issues, mainly as they relate to salmon farming in Northern and Central Europe. He stressed that it is vital for a sustainable development of the industry that environmental issues are carefully assessed and criticism not mislead through emotional or circumstantial observations rather than by scientifically proven facts. The fish farming industry itself acknowledges and supports that if it is to develop and expand, regulations and guidelines must be drawn up to secure a sound development. It is also important to find universally accepted ways of describing how the potential impact should be measured, formulated and evaluated. On such a scientific and universally accepted basis each country and/or region can, with the support of the findings of the Workshop, work towards a mutual consent between the country's authorities and its industry as regards the acceptable limits for the discharge from fish farms in each individual country. Equally as important - if the industry is to survive - is, that it must be accepted and integrated on equal terms with other manufacturing activities and enterprises as a natural part of socuety. This has neither been the case in many European countries. A number of conclusions are drawn with regard to environmental management.

Dr. Frentzoes presented the Position Paper of the "Federation of Greek Maricultures", describing the development of marine farming over the last five years and expressing the need to pay great attention to environmental issues as aquaculture is a part thereof and any disturbances thereto will affect the aquaculture activity itself. However, the organisation felt that existing regulations are confusing and not well structured and would, therefore welcomes standards that will help to establish and regulate the position of the industry on a national and community level. Most of the environmental issues are addressed in a similar manner as outlined in the FES report.

There were extensive panel discussions involving all participants, from which drafting panels prepared contributions to the final report of the Workshop. These contributions and the recommendations arising from them were presented to a full Plenary Session to allow all participants to comment on the conclusions and provide additional information for consideration by the editorial committee. The publication of the final report appeared at the end of April 1993.

Country Reports

Country reports were presented from nine EC member states (Belgium, Denmark, Federal Republic of Germany, France, Greece, Italy, Ireland, The Netherlands, United Kingdom (England), and United Kingdom (Scotland). Reports on the status of regulatory systems for aquaculture waste control were not available from Portugal and Spain. During Part 2 of this session country reports were presented from nine non-EC countries (Austria, Finland, Hungary, Czechoslowakia, Norway, Poland, Sweden, USA and Canada) The full text of each contribution is published in the Workshop Report.

Poster Session

Abstracts of thirty two posters were made available to participants in the Workshop (titles and authors are listed in Appendix 1). These posters covered a wide range of topics in fish-farming, but particular emphasis could be discerned on the control of the impacts of fish farm effluents through careful attention to the planning and design of fish farm enterprises, and through the limitation and treatment of effluents produced. These principles applied equally to fish farming in fresh and salt water.

Computer-based approaches to questions of strategic and local planning (e.g. 10, 19) can be used to reduce conflicts between competing calls on aquatic resources, and to limit the impact of farm effluents on other users of these resources. On a smaller scale,

more directly linked to farm management, modelling of environmental parameters (e.g. 22) can be a valuable tool in decision making.

Probably the greatest source of improvements in effluent quality in recent years has been the continuing development of feed formulations. The better understanding of the balance between energy and protein requirements (e.g. 32) has led to the widespread use of high energy feeds, and significant reductions in P and N content of feed. The potential for increased use of vegetable protein (17,18) instead of fish meal has implications for feed costs, availability and sustainability of levels of aquaculture greatly in excess of current production.

Most of the recent expansion of fish farming in Europe in recent years has been based on intensive systems in both fresh and salt water. Several posters indicated the potential of extensive integrated systems, utilising naturally available primary production, or wastes from other agricultural activities to produce fish without addition of nutrient elements to the water resource. Little use has been made elsewhere of the expertise in these systems available in eastern Europe (4,5,6), or of the potential for improvement and dissemination of the Italian valli-culture systems (27). These systems can be net removers of nutrients from the inflowing water, and may be placed against more complicated systems, involving, for example, recycling (2,21,26). There appeared to be unexplored opportunities for the combination of intensive fish or animal farming with extensive fish farming systems, which might result in considerable improvements in the efficiency of energy and materials use, and net reductions in effluent discharge to the environment.

Particular interest was expressed in experiments which are carried out in Russia (3) to explore the true environmental requirements of fish in intensive culture, and the extent to which the provision of such conditions induced improvements in fish performance and water quality, etc. It had been shown that fish were able to regulate not only their feed intake to appropriate levels using demand feeders, but could also distinguish and select between feeds of different qualities. The fish could be trained to release salt solutions when treatment for external parasites was necessary, and regulate pond conditions through stimulation of lime inputs. The potential for such novel concepts in fish farming remains to be clarified, but has parallels in some branches of developments in intensive animal husbandry.

Comments Arising from Paper Discussions

During the course of the Workshop a theme that was repeated by some scientists and fish farmers was that it is in the interests of the industry to minimise waste outputs. Many of the participants representing fish farmers and fish farming associations expressed concern that, in many cases, freshwater and marine fish farming was often unfairly constrained. For example, in the case of water resources, it was suggested that fish farms do not have equal access to water resources and are often more intensely monitored and controlled by regulatory authorities than other users. While it is recognised that conflicts have arisen, for example between fish farming development and other industries such as tourism and traditional fishing, discussion of these issues were beyond the scope of the workshop.

Although the Workshop focussed upon Fish Farm Effluents, questions of their control and monitoring cannot be separated from other operational and regulatory procedures that influence the quality of effluents and their effects on aquatic environments. At the operational level, farming practices, for example the different methods of feeding fish and the quality of feed used, influence the quantity and quality of effluents. Similarly, the design and operation of effluent management systems are clearly recognised as important factors influencing the final impact of effluents entering the environment.

Although the plenary presentations and the country reports indicated considerable differences between the ecological and regulatory problems presented by fish farming in freshwater and coastal marine areas, there are also many aspects which are in common. In order to allow maximum flexibility in discussing these issues, while also taking advantage of the expertise available to the Workshop, it was decided to hold separate Panel Discussions to cover freshwater and coastal marine matters and combine the results into a unifying document.

There is a wide range of regulations and standards controlling fish farming and the discharge of effluents throughout the EC. These results form a wide range of environmental, economic, and social conditions found within and among individual member states. The diversity of regulations and standards also reflect an attempt to formulate controls appropriate to the different forms of aquaculture and the nature and quantity of wastes discharged.

Reducing effluent output was considered as one obvious method of minimising ecological change associated with the discharge of aquaculture wastes. Key elements in the reduction of waste outputs are: improved feed formulations and farm management (including better feed conversion ratios); mechanical methods (filters); improved disease prevention. In addition, the use of integrated culture systems with recycling and utilisation of waste may also represent a means of reducing waste discharge.

Main Issues Arising From Panel Discussions And Drafting Group Sessions

General Statement

Although the discussion sessions were divided into freshwater and marine it became clear that most of the issues discussed were common to both. For this reason presentation of the discussions has been combined. Much of the discussion related to planning, management and monitoring are presented below. An outline of one suggested method of how planning, and ecological assessment at the national, regional and site specific level with regulatory monitoring has been summarised in Figure 1 (presented at the end of this section).

Regulations

It is clear from the country reports and panel discussions that there are a wide range of regulations and standards controlling fish farming and the discharge of effluents throughout the EC. This is due in part to the wide range of environmental conditions found both within and amongst member states. In addition, the diversity of regulations and environmental standards reflects differences in fish farming technology, the species farmed, and the nature and quantity of wastes discharged. Harmonisation of regulations and standards throughout the EC would be a difficult task and in many instances is not considered desirable.

Reducing Effluent Output

Reducing waste output is an obvious method of minimising the ecological change associated with the discharge of fish farm wastes and it is clear that in recent years

there has been a significant reduction in feed wastage. Key elements in reducing waste output were considered to be:

(I) improved husbandry, for example the separation of year classes in salmon farming to reduce the risk of disease and the need to use of antimicrobial agents;

(II) Optimisation of feeding strategies to reduce wastage;

(III) Improvements in feed formulations (see for example, Hole and , this volume)

(IV) Development of efficient mechanical methods (filters) to remove wastes (see for example Cripps, this volume).

In addition, the use of integrated culture systems (see for example, Grimaldi and Ravagnan, this volume) with recycling and utilisation of wastes in other production systems may also serve as a mechanism for reducing waste discharge, although the transfer of disease and/or chemicals between different components of the integrated system would need to be carefully evaluated.

Pro-active, Integrated Planning and Management

One of the criticisms of the expansion of fish farming is that in a number of countries development appears to have taken place in the absence of any planning strategy. A common point made by many fish farmers, fish farming organisations and their representatives is that disproportionate levels of control and monitoring of effluents are placed upon fish farming compared to other users of the aquatic resource (see comments by Myrseth, this volume). As a result, conflicts have arisen between the proponents of fish farm development and other users of inland and coastal marine waters. This potential for conflicts has, in some countries, been compounded by the lack of a balanced assessment of the full environmental (social, economic, ecological) effects (beneficial and negative) of fish farm development. One reason for this is that policies which have been designed for ecological protection and regulation of waste discharge or release in other circumstances are bein constantly adapted to control aquaculture. As a result, the formation of planning guidelines and environmental quality standards or targets have followed rather than led the industry. It is clear therefore that further adoption of policies and laws designed to address environmental issues related to other activities is not appropriate to the sustainable development of fish farming and the integration of fish farming with other users of the aquatic resource.

A pro-active aquatic management framework is required for both fresh and marine waters. Such a framework should allow for the equitable use of coastal resources to the benefit of all potential users. This should, for example, include cost of water abstraction which should be proportional to usage. Improved international guidelines (EC wide) on coastal and freshwater management should be developed and used as a framework for the development of national and regional management plans by policy makers, planners, and land and water use managers. Such a framework would play a valuable role in protecting the environment and should include:

(I) the recognition of aquaculture as a legitimate use of the aquatic resource. Policies need to be formulated to give recognition to the positive role that fish farming can play in diversifying and expanding the economic base of local communities, together with regional and national economies.

(II) comprehensive national water resources management policies that address all activities that may have a detrimental effect on water flow and quality and should :

a) give full consideration to all forms of water use within individual catchments and the coastal area, including any modifications to the quantity and quality of freshwater entering the coastal environment.

b) include standards of waste discharge which are applied equally to all users of the aquatic resource. Specific issues which need to be addressed include: the need to control and monitor water abstraction from; non-point sources of nutrient release such as forestry and other extensive forms of land use which involve the use of fertilizers, pesticides and herbicides; wastes from intensive rearing of livestock.

c) involve aquaculturists and aquaculture development experts in the planning process to ensure appropriate criteria are used in the designation of potential sites.

(III) the development of national, integrated coastal management programmes which are amenable to intersectoral national co-ordination should be developed for example like the Norwegian LENKA and Canadian CRIS approaches (see Black, this volume). These procedures could form the basis of an EC wide framework and supporting guidelines.

(IV) procedures for assessing the capacity of different aquatic ecosystems (lacustrine, reverine and coastal marine) to assimilate inputs from aquaculture and all other activities. This type of assessment should be undertaken on a regional scale.

Environmental Assessment

It is suggested that greater use should be made of the EC directive on environmental assessment (EA) which should be an integral part of any national management framework and assessment procedure. Properly formulated EA is a valuable tool for the evaluation of site specific ecological change and should:

(I) be undertaken within the framework of regional coastal area or water resource management plans, thereby ensuring that the scope of any assessment is proportional to both the scale of the proposed development and the perceived sensitivity of the recipient water body;

(II) be undertaken before the necessary licences/permits for fish farming are granted;

(III) be formulated in such a way that an evaluation of the need for and level of monitoring is possible. If monitoring is required, EA should additionally provide reference data which can be used to establish an appropriate monitoring programme including the identification of suitable locations for sampling and reference stations.

Monitoring

Intensive land-based fish farms are normally treated as point sources of effluent inputs to the aquatic environment. As such, monitoring of these effluents is relatively easy compared to diffuse sources such as agriculture and forestry. In contrast to point source discharge from industry, however, land-basedd fish farm effluents are characterised by high volumes of water and low concentrations of dissolved and particulate waste.

The purpose of monitoring should be defined before a monitoring programme is designed and it is important to distinguish between monitoring which may be undertaken by a regulatory authority for pollution control/ecological protection and monitoring

which may be undertaken by the farmer as part of farm management. This distinction does not imply that monitoring for these two purposes are exclusive and there may be considerably benefit in co-operation between the farmer and the regulatory authority. Nevertheless, because of the implications of regulatory monitoring (a requirement to reduce the level of farm production if monitoring indicated that ecological standards or targets have been exceeded) any monitoring undertaken jointly by the farmer and regulatory authority must be under the control of the latter.

The following general principles associated with monitoring for regulatory purposes were identified:

(I) In general, the conditions of a licence to farm fish should include any requirement for monitoring. Implicit in this would be a requirement to modify the level of production should the results of monitoring indicate that ecological standards or targets have been exceeded.

(II) A flexible approach should be taken to monitoring for two reasons:

(a) to maximise use of resources, the level of monitoring should be related to the level of farm production and the sensitivity of the ecosystem receiving the waste (determined by the regional assessment of ecosystem capacity and the site specific environmental assessment).

(b) Because local physical features (such as bathymetry and water flow) will influence the effects of fish farm waste on the aquatic ecosystem, monitoring should be restricted to key variables (see below), identified as being the most important indicators of the anticipated changes. Key variables should be identified during the environmental assessment.

(III) It is only appropriate to collect quantitative data for regulatory monitoring and such programmes should be designed to provide data which are amenable to statistical analysis so that a level of confidence may be given to any changes detected. The data should therefore be collected in accordance with the best quality assurance practices. This may involve the use of impartial third party auditors with appropriate accreditation under a recognised scheme.

(IV) Analysis of the data should be regarded as an integral part of the monitoring procedure and, when the data collected indicate that ecological standards or targets have been exceeded, farm management or level of production should be modified to reduce waste output. The data collected from monitoring programmes should also be used to: assess the reliability of the initial ecological assessments at both the site-specific and if appropriate the regional level; evaluate and if necessary modify the monitoring programme itself. Details of monitoring protocols and the results obtained from monitoring should be made available to the fish farmer and the general public to ensure confidence in the planning process, ecological assessment and monitoring.

V) Any assessment of monitoring data must be made in relation to pre-defined ecological criteria or target values (see below). The spatial and temporal scale of monitoring must be sufficient to allow confident detection fo the degree of change implicit in the standards or targets, and therfore discriminate between ecological change and natural variation in time and space.

VI) Where appropriate monitoring protocols exist (e.g. in advice from EIFAC and ICES) these should be adopted for use in relation to the effects of fish farm waste.

Variables and Ecological Standards or Targets

For land-based fish farms the amount of feed (volume and quality) and effluent can be monitored directly. Effluent standards should be set on the difference between concentrations of variables in the inflow and outflow, taking into consideration the quality objectives for the receiving water. In this respect the work of EIFAC (15th Session of the Working Party of Fish Farm Effluents, June 1987, Appendix II) may be of value.

For monitoring both the influent and effluent a number of variables have been broadly recognised as being the most appropriate and include:

- Total water flow
- Suspended solids
- pH
- Dissolved oxygen.
- Biochemical and chemical oxygen demand
- Total nitrogen and phosphorus
- Ammonia.

In relation to cage fish farming the situation is more complex. Since there is no well defined effluent, the concept of effluent standards does not apply. It is therefore more practical to make direct measurements of the effects of fish farm waste on key components of the aquatic ecosystem. In some countries for example, features of the benthic ecosystem (redox potential, changes in the population structure of the benthic macrofauna), levels of dissolved nutrients and chlorophyll related phytoplankton biomass have been monitored for regulatory purposes. These are however, no widely recognised standard variables for monitoring. Furthermore, in view of the localised nature of ecological change and the influence of local physical features (bathymetry and water movement) on the scale and nature of the ecollogically most relevant impacts, key variables to monitor may differ at different fish farms. It is doubtful therefore, whether EC wide standard requirements for monitoring could be established.

There is a need for international agreement on which variables provide the best indicators of ecological change associated with fish farm waste and this should be coupled with international standardisation of methods (from sample collection storage/preservation to analysis). For this purpose the work of international agencies may be of value. In particular, the EIFAC Working Party on Fish Farm Effluents (see reports EIFAC/XV/88Inf.19 and EIFAC/XVII/92/Inf.4) for freshwater and ICES and GESAMP for marine waters are considered most relevant.

There are a number of EC directives which relate to the quality of fresh and coastal marine waters (see Piccioli, this volume). Nevertheless, it is clear that there is a need for the establishment of standards or targets which are based on sound scientific criteria and are ecologically relevant (see Gowen, this volume). Such standards have an application which extends beyond fish farming and this topic is therefore of considerable importance. The development of appropriate standards or targets is currently under consideration by a number of national and international groups. This will be a difficult task but is clearly an important one (see comments by Eleftheriou and Silvert this volume) which should be continued.

Chemical Usage in Fish Farming

Chemicals and chemical residues derived from the use of therapeutants, anti-microbial agents and treatment against external parasites are considered to be one of the most important components of fish farm waste. Concerns relate to the ecotoxicology, bioaccumulations and potential for some of these chemicals to induce disease resistance in bacteria. In some countries, there is a strict system for the assessment and licensing of veterinary medicines in which hazards to the user, consumer and ecosystem are considered.

Figure 1: A Suggested Method of Integrating Marine and Freshwater Management with Environmental Assessment and Regulatory Monitoring

International Level (EC responsibility)

Guidelines on freshwater and coastal management
To include:

1) recognition of aquaculture as a legitimate use of aquatic resources,
2) an evaluation of the ecological consequences of all potential users.
3) procedures for assessing the ecological capacity of aquatic ecosystems,
4) the application of standard criteria for the discharge of waste to all users of the aquatic resource.

National Level (Governmental responsibility)

Pro-active aquatic resource management
To include:

1) an evaluation of the capacity of the receiving water (e.g.watershed, coastal area) to assimilate waste from all developemnts

Requires:

1) development of models to predict ecological change
2) establishing of ecological standards or targets

Regional Level (Regulatory Authority responsibility)

Site Specific Environmental Assessments

It is suggested that this is the responsibility of the developer but scope and content of EA must be decided by the regulatory authority and should:

(1) be related to the size of the proposed development
(2) be related to the ecological sensitivity of the area

Local Level (Regulatory Authority resonsibility)

Monitoring

There may be co-operation with the fish farmer but for regulatory purposes the relevant authority determine the scope of the monitoring but should relate monitoring to:

(i) size of the fish farm
(ii) sensitivity of the coastal area based on CZMS and EA

Evaluation

Evaluation of data together with data from the monitoring of other developments should be used to:

(i) determine whether ecological targets or standards have been exceeded and if necessary
(II) regulate waste output from all developments
(iii) evaluate the need to modify the monitoring programme
(iv) evaluate assessment of ecological capacity of the water body

Monitoring undertaken by regulatory authorities should include an evaluation of chemical usage and the likely mode of impact on the aquatic ecosystem. In many cases however, the potential for the economic measurement of variables critical to the assessment of the impact of such chemicals is limited. There is, therefore, a need to address this question.

Recommendations

A number of recommendations were formulated by the workshop which can be tentatively summarized as follows:

1. The EC should develop a framework within which member states would be called upon to prepare coastal zone management plans.

2. The EC should encourage member states to formulate comprehensive water resources management policies that address all activities that may have a detrimental effect on coastal water flow and quality.

3. The EC should review methods for the ecological assessment of wastes discharged to the coastal zone with a view to recommending criteria for such assessments.

4. The EC should recommend analytical methods for critical variables in ecological assessments and monitoring, and prepare appropriate certified reference materials through the Community Bureau of Reference (BCR). Intercomparison exercises should be organised involving key laboratories.

5. That member states be encouraged to prepare coastal zone management plans initially concentrating on areas where conficts between potential users may occur.

6. In order that the discharge of effluents from aquaculture operations is properly controlled, well defined regional plans should be prepared at national level to ensure the equitable use of the aquatic resource.

7. Member states should be encouraged to make greater use of the EC Directive on Environmental Impact Assessment (85/337/EEC) in deriving ecological assessments of fish farming development proposals. This may require member states to revise their interpretation of the Directive such that a greater proportion of proposals are subjected to EA.

8. Assessment of the capacity of individual sites should be undertaken by individual states. The EC should seek to harmonise procedures for assessing the ecological impact of aquacultue wastes among EC nations.

9. Methods should be developed for monitoring the impact of the use of therapeutants in mariculture on the ecosystem. The Workshop supported moves within the EC towards harmonisation of the licensing veterinary medicines.

10. It is recommended that the EC arrange for the organisation of a symposium at which the capabilities and potentials of the range of models for predicting the effects of fish farm effluent on the environment, and the ability of the environment to accommodate these effects, which are presently available or under development may be compared and contrasted, with a view to sharing experience, and more effectively directing research effort.

12. It is recommended that comparative studies on environmental legislation governing aquaculture such as the ongoing EIFAC survey being carriet out by the FAO Legal Office, should be further supported and encouraged for the purpose of coastal aquaculture including shellfish farming.

Priority research needs were also identified. These include:

1. The development and validation of models for:

   a) predicting the scale of impacts associated with aquaculture waste,
   b) predicting the capacity of water bodies to assimilate anthropogenic inputs.

2. The development of cost-effective instrumentation and techniqges for the assessment and monitoring of the effects of chemicals used in fish farming and the impacts of fish fsarm waste on the ecosystem.

3. The continuation of work to develop improved techniques for disease prevention and control leading to reduced requirements for therapeutic chemicals.

The Workshop was supported by various sponsoring organisation, including the EC-Commission, EIFAC (European Inland Fisheries Advisory Commission), the Federal Ministry of Nutrition, Agriculture and Forestry of the Federal Republic of Germany, the Ministrie van Landbouw, Natuurbeheer en Visserij, The Netherlands, the Danish Aquaculture Society, the Dutch Aquaculture Society, the German Fisheries Association, the European Aquaculture Society, and last but not least the City of Hamburg.

The overviews presented in the Plenary Sessions and the Poster Papers for which written manuscripts have been received will be published after peer review in a special issue of the Journal of Applied Ichthyology. It is anticipated that the issue will be published in late October 1993.

Appendix 1

Poster presentations

Allocation of posters to topic groups

A1	FRESHWATER PLANNING etc	1, 2, 14, 21, 29
A2	FRESHWATER EFFLUENT CONTROL ETC	3, 4, 5, 6, 8, 12, 13, 17, 18, 19, 28
B1	SALT WATER PLANNING etc	10, 15, 22, 24, 27, 30
B2	SALT WATER EFFLUENT CONTROL etc	7, 11, 16, 20, 23, 25, 27

Poster titles

1. Thomas Balling: Seasonal and location dependent propagation of fish parasites in Lake Constance and their effects on fish condition
2. Alexandre Kiselev: "Die geschlossenen Systeme in der Aquakultur" *Closed systems in aquaculture*
3. Sergey B. Mustaev: A new approach to mitigating environmental effects from aquaculture systems
4. J.Oláh, F. Pekár, P. Szabó: Nitrogen cycling and retention in fish-cum-livestock ponds
5. J. Oláh, P. Szabó, A.A. Esteky, S.A. Nezami: Nitrogen processing and retention in a Hungarian carp farm
6. Tamara You. Zemlyanitsina: Advantage of intensive fish pond fertilization in relation to phyto-plankton requirement
7. Kenneth Black, Ivan Ezzi, and Marius Kiemer: Influence of self-pollution from fish farms on fish health
8. Bernhard Rennert: Water pollution effects by a land-based trout farm
9. Maria Leonor Fidalgo: Effects of a rainbow trout farm in Canicada Reservoir during Spring and Summer months 1992
10. Guy Houvenaghel: Offshore salmon farming operation: Hydrological tracking of the effluents
11. Peter Smith: Fate and impact of oxytetracycline used in fish farms: methodological considerations
12. Liam A. Kelly and A. W. Karpinski: Monitoring of BOD outputs from land-based fish farms
13. Liam A. Kelly and L. Heerfordt: Waste loads and Treatment System efficiencies of Danish and Scottish Salmonid farms
14. Fiona Gavine: Control, regulations and monitoring of freshwater cage farms in the UK - Comparison with the Irish Situation
15. Wolfgang Welsch: A new concept for semi-intensive cage-co-culture of salmonids and blue mussels
16. Peter Krost, Thomas Chrzan, Hartmut Schomann, Harald Rosenthal: Effects of a floating fish farm in Kiel Fjord
17. M. Rodehutscord, S. Mandel and E. Pfeffer: Reduced protein content and use of wheat gluten in digests for rainbow trout: Effects on loading water with N and P
18. M. Rodehutscord, H.F. Schulte and E. Pfeffer: Digestable Energy in Feedstuffs used for Rainbow Trout
19. R.H. Foy: Nitrogen and phosphorus fractions from a rainbow trout farm and the influence of phytoplankton.

20. Magnus Enell: Nutrient loads on the Baltic Sea from Swedish and Finnish fish farming in comparison to total inputs

21. Roy Arbiv and Jaap van Rijn: Nitrate removal by fluidized bed technology in intensive fish culture systems

22. Andrew Boghen: Monitoring Oyster-Farming Systems in New Brunswick, Canada

23. B. W. Munday and P. Divanach: Quantitative statistical analysis of the literature concerning the interaction of the environment and aquaculture - identification of gaps and lacks -

24. Vulker Ide and Andreas Stief: Sewage sludge treatment by Nereis diversicolor

25. Peter Krost, Dror Angel, Daniel Zuber and Amir Neori: Microbial mats mediate the benthic turnover of organic matter in polluted sediments in the Gulf of Aqaba

26. Hermann Sich: Ouflow of bacteria and particulate matter from a semi-closed, intensive, concrete fish culture unit.

27. Gino Ravagnan: "Hydrocultivator" a technique to stabilze highly eutrophic waters in the Venetian region

28. Mark Nijhof: Theoretical effects of feed composition, feeding rate and feed spilling on waste discharge in fish culture

29. William Silvert: Decision Support Systesms for Aquaculture Licensing

30. William Silvert: Simulation Models of Finfish Farms

31. Anders Alanärä, Asbjørn Bergheim, Simon J. Cripps, Robert Eliassen and Rolv Kristiansen: An integrated approach to aquaculture wastewater management

32. K.-H. Meyer-Burgdorff : Nutritional strategies to reduce phosphorus excretion of farmed fish: