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Progress Report of the Working Group on "Environmental Interaction of Mariculture"

prepared by

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Introduction

The Working Group continued to work by correspondence during the 1992/1993 inter-sessional period. A sub-group (with membership of Rosenthal, Gowen, Black, Davies, and Alderman) met in November in Hamburg at the time of the EC Fish-Farm Effluent Workshop to review progress of the Working Group.

Because of the largely fulfilled tasks of the "Working Group on Environmental Impact of Mariculture" the Working Group proposed to the parent Committee at the 1992 Statutory meeting to adjust the objectives of the WG in order to reflect the new direction of mariculture's environmental issues related to mariculture. This also requires a name change for the group. The proposed name would be the "Working Group on Environmental Interactions of Mariculture" which would broaden the present mandate of the Group to address the interactions between mariculture and other uses of coastal marine resources. It would also provide advice on new strategies for site selection as well as improved approaches for criteria development and systems for monitoring and reporting. The Committee endorsed this proposal.

The new Terms Of Reference

The proposal was adopted by the Council under Council Resolution C.R. 1992/2:45 which reads as follows:

The Working Group on Environmental Impact of Mariculture will be renamed the Working Group on Environmental Interactions of Mariculture to reflect a broadened interaction of mariculture with other human activities in coastal areas with extended terms of reference including:

- a) developing criteria and a standard system of monitoring and reporting;
- b) delineating the scope and nature of environmental interactions between mariculture and other uses of coastal marine resources;
- c) providing advice on approaches in such areas as improved site selection and through advances in husbandry to minimize conflicts between mariculture and other coastal zone activities;
- d) reviewing and evaluating national monitoring programmes and preparing regular status reports on the impact of mariculture within ICES.

The Working Group will work by correspondence in 1993, with a view to meeting in 1994 to:

- a) update the catalogue of ongoing research programmes on environmental interaction issues related to mariculture;
- b) examine biological interactions between types of mariculture and other coastal zone issues;
- c) identify major long-term research priorities, particularly in the subject area of resolving conflicts in use of the marine environment;

- d) assemble and compile, intersessionally, information on ongoing monitoring programmes in each country related to the assessment of the impacts and interactions of mariculture, with a view to its publication in the ICES Cooperative Research Report series;
- e) evaluate the potential environmental effects of new mariculture systems in ICES Member Countries;
- f) assemble and comment on the evidence for the interaction of complexed and/ particle-bound contaminants (e.g. antibiotics, antifoulants, parasiticides) from fish farms with marine flora and fauna, and the significance of these interactions with marine ecosystems;
- g) prepare guidelines on the ecotoxicological information necessary to permit assessment of the relative environmental impacts of the therapeutants.

Intersessional Activities of Working Group Members

Workshop on Fish farm effluents and their regulation in EC countries

Several members of the ICES Working Group were involved in the organisation of this workshop and participated with a number of specific contributions which were closely related to the new terms of reference of the WG. The recommendations prepared during panel and drafting sessions by various sub-groups and conclusions drawn from position papers contributed by various organisations and individual participants can be summarized as follows:

Recommendations

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. That 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 conflicts 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 aquaculture 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 carried out by the FAO Legal Office, should be further supported and encouraged for the purpose of coastal aquaculture including shellfish farming.

Priority Research Needs

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 techniques for the assessment and monitoring of the effects of chemicals used in fish farming and the impacts of fish farm 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.

A detailed report on the outcome of the Workshop is presented in paper CM1993/F: 13 "Aquaculture and environmental regulations in EC countries (a report on the outcome of a Workshop held in Hamburg 23-25 November 1992).

Withdrawal times for certain drugs in some ICES member states

The European Association of Fish Pathologists issued and circulated a questionnaire on the use of drugs in fish and shellfish. It is claimed that previous questionnaires undertaken by other organisations have largely addressed governmental authorities which have not necessarily been well informed on fish and shellfish-specific details. The results of the response have recently been made available (see reference Anonymus 1992). The data obtained relate also to the withdrawal periods required in various states for certain chemicals. Those relevant to the ICES area are summarized in the following table.

Table 1: Withdrawal times for certain drugs in various countries. Result of a questionnaire of the EAFP 1991 (Anonymous, 1992, modified)

	OTC (1)	OA (2)	TCF (3)	TMP/SA (4)
Finland	>9°C : 40d <9°C: 80 d	>9°C : 40d <9°C: 80 d		>9°C : 40d <9°C: 80 d
France	500°d 21-30d	6d 14d	14d	500°d 21d
Germany	(30 d)	no licence	21d	41d
Italy	30d			
Japan	20-30d	14-30d	5d	
Norway	>12°C: 40d 8-12°C: 60-180d <8°C: 180d	>12°C: 40d 8-12°C: 60-180d <8°C: 60	21d DCV: 14d	>12°C: 40d 8-12°C: 40-90d <8°C: 90d
Sweden	>9°C: 30d <9°C: 60d	>10°C: 40d <10°C: 80d		
United Kingdom	400°d	200°d	DCV: 4d	500°d

(1) OTC = Oxytracycline; (2) = OA = oxolinic acid; (3) = TCF = trichlorphon; (4) = TMP/SA = trimethoprim/potentiated sulphonamides; DCV = dichlorvos

Because of the importance of the issue on withdrawal times, we report on the observations made by the EAFP on the changes in the regulations for drugs in fish and shellfish in various countries. Even within EEC member states, there is no uniform picture. The main problems as identified by EAFP are cited in the report as follows:

- "- lack of drugs registered specifically for fish,
- a wide-spread off-label use or illegal use of drugs,
- difficulties in establishing withdrawal times,
- a need to standardise methods,
- growing concerns about possible environmental impact."

In the EEC a number of related directives are coming into force in the near future. These include "Directive No. 81/851/EEC" and its recent amendment by "Directive No 90/676/EEC". For the first time, fish as an animal has been explicitly mentioned in these amendments. This means that in future, Community legislation governing veterinary medicinal products fully applies to drugs for use in fish. This has implications for marketing authorisation with subsequent EEC requirements regarding maximum residue levels, extra-label use and other technical regulations.

Recent research activities in some ICES member states

An attempt was made to update the list of ongoing, completed and new projects related to environmental issues of mariculture. This is considered to be a continuing exercise to fulfil one of the objectives of the Working Group, namely to identify priority research needs within the ICES area. Although this exercise is always undertaken during the intersessional period in preparation for the next working group meeting, the material assembled so far is incomplete and does not allow a listing in this interim report, although several Working Group members and scientists from member states have provided documentation to the WG Chairman. This information has not always been cross-checked and confirmed by the national WG member. I have, however, briefly report on several progress reports and publications in order to facilitate exchange of information. For detailed information the appropriate Working Group member (addresses can be found in Appendix 1) should be contacted.

Canada:

Geographic information system (Prince Edward Island)

A Geographic Information System (GIS) is used to evaluate the extent to which the closure of shellfish areas due to bacterial contamination effects the shellfish industry in Eastern Prince Edward Island. The GIS system is used to determine the area of shellfish growing leases, shellfish harvesting and contaminated closure zones. A comparison is made between the areas and an estimated value is determined. Further uses of the GIS are presently explored, in particular, its use as a planning tool to avoid pollution sources and to assist in prioritizing research surveys. (reference see Legault, 1992).

Modelling environmental impact

Work on modelling environmental aspects of aquaculture operations in tidal coastal waters continued in an attempt to assist licensing authorities in estimating the potential impacts of new lease proposals. In a recent publication (Silvert, 1992, see literature list) the author, who is involved in the development of environmental models, outlines the difficult scientific issues to be resolved before one can expect to be able to have fully quantified models available. However, the models described are of a form that makes it possible to combine many of the scientific uncertainties into one or two numerical values that can be assigned conservative values until scientific research can provide definitive results. It is argued that application of risk analysis to the confidence limits derived from scientific observations provides at least a defensible basis for policy formulation. The models were presented as posters and a Demo-version of the computer programme was shown to participants at the Hamburg Workshop on "Fish Farm Effluents and their Control in EC Countries"

Monitoring issues

During 1992, the baseline study (New Brunswick Environment) of all existing salmon cage sites of the province was completed (see literature list, Thonney and Garnier, 1993). The following information is extracted from the report.

The field component of the 1992 program of both the baseline study and new site assessments consisted of collection and analyzing seafloor sediments, biological specimens and oceanographic information to provide a site by site assessment of impacts on the surrounding environment. A total of 52 sites were monitored. It is claimed that the results of the baseline survey have contributed to (a) identify important parameters for conducting site assessments, (b) develop a sampling protocol for implementing site evaluations, and (c) provide site specific mitigative recommendations designed to minimize impacts. Examination of data showed that sites prone to excessive organic accumulation had specific ratios of silt/clay contents, currents of less than 5cm/sec, background (control) sediment organic content greater than 6%, and depths of less than 10m at mean low tide.

A comprehensive study (see Cross, 1993) was also implemented at the West Coast of Canada to document the oceanographic, physiographic and bathymetric characteristics at five salmon net-cage facilities considered to represent coastal areas regarded as optimal for finfish culture in British Columbia. In addition to documenting bathymetry, water quality and circulation dynamics, the study also estimated farm-derived sedimentation rates (organic material inputs) and reported epibenthic observational information for each of the 5 study sites.

West Coast considerations of environmental interactions of mariculture

Information has also been received from the west coast (E.A. Black (Victoria, B.C.)).

A one day meeting was held in June 1993 in Victoria, British Columbia, on "Fisheries and Aquaculture Interaction". The organizers (Ministry of Agriculture Fisheries and Food of British Columbia, Victoria, Canada) put together some notes containing abstracts of contributors and "Audience Notes" of the meeting. Most of the subjects dealt with are of interest to the Working Group and considered the following subject areas:

- Benthic studies,
- Interspecific interactions
- Disease
- Escapes and genetic implications.

The contributions on benthos interactions included the following presentations:

- Studies on sedimentation and recovery
- Sites associated with limited sediment built-up
- Evidence of fish feeding on waste feed
- Limiting sedimentation by controlled feeding.

Topics discussed on interspecific interactions were:

- caged fish predation on feral populations
- Sedimentation effects on herring eggs
- Mammalian predators on caged fish

With regard to disease the following subjects were addressed:

Fish farms as the initiator of algae blooms

- Fish behaviour and stress mediated disease occurrence
- Lessons from Marine Anaemia, IHN and VHS (Norwegian Workshop)
- Investigations of potential disease reservoirs.

Documentation (Fisheries-Aquaculture Interactions: Bullpen Notes) on this meeting can be obtained through E.A. Black, Victoria.

Federal Republic of Germany

A study was started on the geochemistry of sediments under a small cage farm in the Kiel Bight located in the effluent plume of a coastal power station. The investigation focusses on the structure of accumulated sediments, nutrient fluxes within layers, and nutrient release to the water as well as rates of gas ebullition. It is intended to relate the data to the history of the culture unit which is in operation for over 10 years.

A comparative study is also under way to estimate the organic load derived from cage farming of rainbow trout along the Baltic coast of the new "Länder", in particular in those farms which continued operation after the unification of Germany. Results of this comparative study are expected to be reported to the WG at the next meeting.

Ireland

A study is presently underway on the effect of harrowing and fallowing on sediment quality under a salmon farm on the west coast of Ireland. The study was designed to describe pre- and post-harrowing sediment conditions following a fallowing period under a salmon farm. Such values as depth of the redox layer and types and numbers of benthic animals were used to describe the conditions which pertained both before and after the harrowing took place. The data of this study are presently analysed and a report is anticipated in the near future.

Norway

Characterization of treated and untreated effluents from landbased fish farms.

In a recent study by Eikebrokk and Ulgenes (1993) it is suggested that removal of particles from fish farm effluents may lead to substantial reduction of the environmental impact of effluents from land-based salmon farms. Based upon results from commercial scale experiemnts, the study characterized treated (micro-strained) and untreated effluents from Atlantic salmon smolt production and Atlantic salmon grow-out units, with respect to concentrations and total discharges of suspended solids, organics, nitrogen and phosphorus. Sludge characteristics have been determined and the effectiveness of various commercially available microstrainers for particle removal were tested. The available data suggest that commercially available microstrainers (60 μ m) may reduce the effluent discharge levels by 70%, 44%, 57%, and 37% for suspended solids (SS), organics (COD), total phosphorus (Tot-P) and total nitrogen (Tot-N), respectively. Some options to use the data base to determine general effluent quality standards are discussed. The data on the effectiveness of available effluent treatment technology for flow-through systems suggest that with good hydraulic design criteria acceptable standards (maximum discharge levels) for smolt and grow-out units can be developed.

Separation of farm operations and year classes

In an attempt to prepare for future expansion of the Atlantic salmon farming industry in Norway, studies have been initiated that explore operational strategies to maintain year classes and farmers separate in order to minimize disease risks.

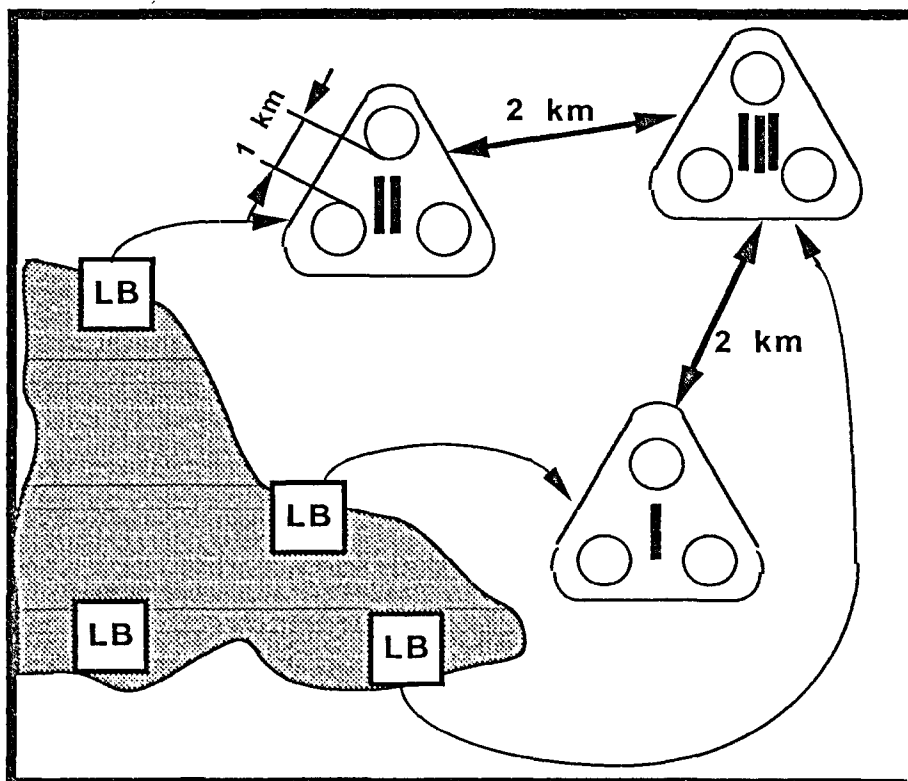


Figure 1. Separation of farm operations by area and of year classes within licences (with permisson from Dr. H. Rudi)

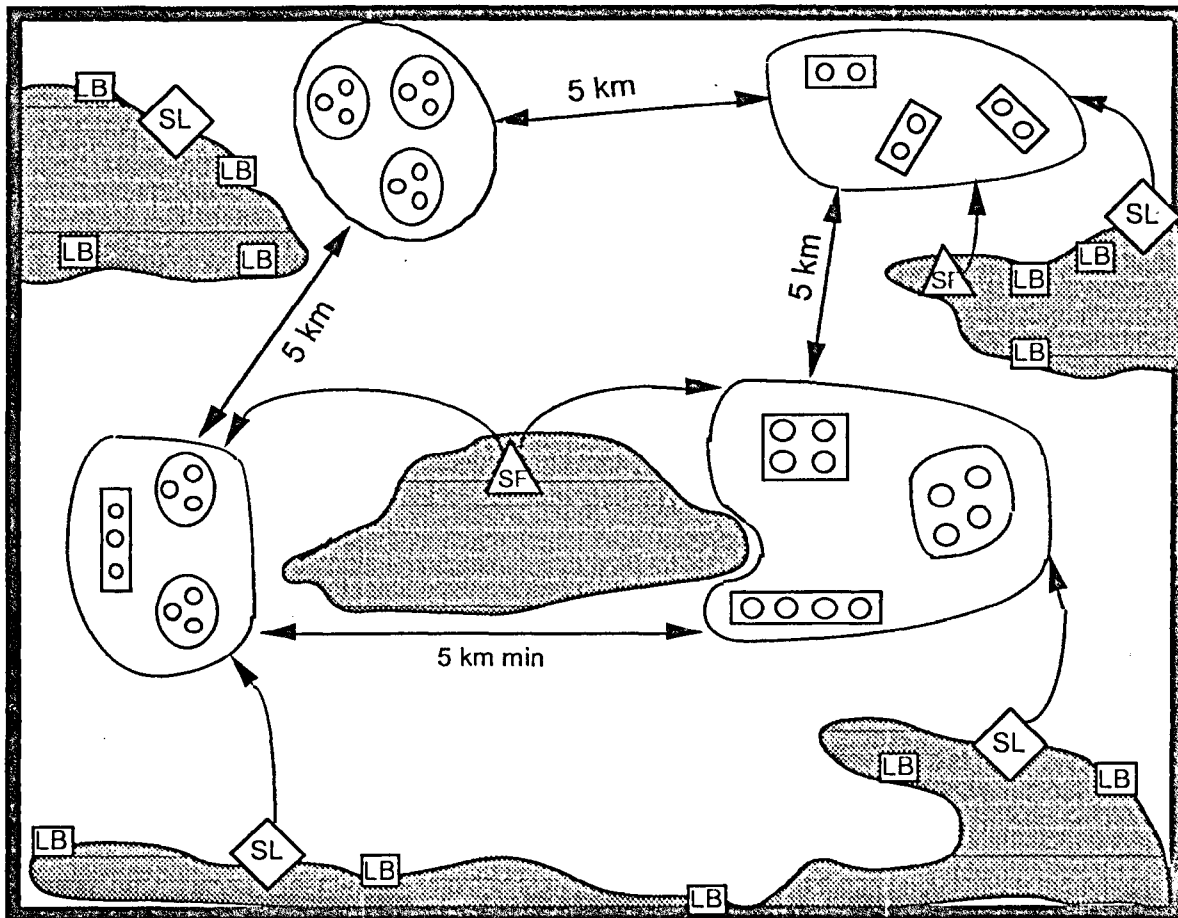


Figure 2. Suggested separation of operational farming steps to reduce environmental problems. SL = processing of harvest; LB = land-base of farm operations; SF = smolt production unit. (pers. comm. Dr. Rudi, Norway)

The strategy employed on a trial basis attempts to separate year classes. For such purposes farmers need at least three sites to stock smolts in subsequent years. One way achieving it may be by joining activities of several farmers ((Fig. 1) and have for each site a separate home base with equipment (nets, boats, etc) in order to avoid cross contamination. If the industry expands there is also a plan to separate processing (slaughtering) smolt production and operational units and extend the distances between net cage flotillas (Fig 2.)

Control of sea lice

The use of hydrogen peroxide as a delousing agent has been studied by Thomassen (1993). When lice-infested salmon are exposed for 20 minutes to a hydrogen peroxide concentration of 1.5g/L, about 85% to 100% of the adult and pre-adult lice will be removed. Hydrogen peroxide was found to be most effective against preadult and adult stages of sea lice, although substantial numbers of chalimus stages were also removed. Although hydrogen peroxide is toxic to salmon (concentration dependent), fish will survive 1.5 mg/L at temperatures up to 18°C and exposure times less than 30 minutes. In another study (Kvenseth, 1993) it was found that wrasse can be used to control sea lice. However, the success depends on the numbers involved. About 17,000 wrasse were stocked together with 530,000 Atlantic salmon smolts in 6 net cages in a region experiencing heavy salmon lice problems in 1992. The addition of cleanerfish has kept the salmon relatively lice free over a period of 10 months after transfer to the net cages.

The costs of using wrasse as cleanerfish is for the first year in the cages estimated to be not more than 50% of the costs of a single chemical delousing activity using hydrogen peroxide. The author states, however, that hydrogen peroxide represents at the present time the environmentally most friendly chemical delousing method available. Nevertheless, studies on the use of cleaner fish will continue in 1993.

United Kingdom

A study on directly counted bacteria in a trout farm and its effluents was reported by Carr and Goulder (1993). Bacteria increased in abundance in water passing through a trout farm in north-east England and were not removed by a settling lagoon. Total bacteria in the effluent were such that they might potentially bring about immediate increase in the bacterioplankton populations of recipient rivers. Although this study was performed in freshwater, much can be learned from this study when considering land-based marine farms

Interactions between wildlife and aquaculture were also studied in England. A recent publication discusses predation by grey herons at cage fish farms in Argyll, western Scotland (Carss, 1993). This two year study assessed abundance of herons on sea loch shores, running and standing freshwater bodies and at the trout farm. Herons visited the farm almost exclusively at night or during twilight periods and, as a consequence, were seen more often by farm staff in winter than in summer. It is also claimed that by recording only wounded fish, farm staff considerably underestimated their losses to heron. Nevertheless, the study states that losses were small compared with other forms of fish mortality.

Further projects in England and Wales are presently in progress and relate to the following subject areas:

1. Persistence of TBT in the marine environment in England and Wales (M.J. Waldock, Fisheries Laboratory, Burnham on-Crouch, Essex). The programme will terminate by the end of 1993, the report is in press.
2. Impact of Manila clam (*Tapes philippinarum*) cultivation on infauna (B.E. Spencer, Fisheries Laboratory, Conwy, Gwynedd). The project is expected to continue until 1996.
3. Movement, growth and survival of hatchery-reared lobsters released onto natural and artificial reefs in the sea. (J.F. Wickins, Fisheries Laboratory, Conwy, Gwynedd). The project has started in 1992 and will terminate in 1995.
4. Characterization of natural and artificial habitats for lobsters. (J.F. Wickins, address see above). The project will terminate in 1995.

Interactive Consultations with the GESAMP Working Group on "Aquaculture and the Environment in Coastal waters"

Contacts between GESAMP and ICES Working Group members regarding the WG 31 on "Environmental Impacts of Coastal Aquaculture" continued during the intersessional period. Assistance was given in developing terms of references for the next phase of WG31 activities. GESAMP agreed to concentrate its effort on the following aspects:

- (1) the establishment of scientifically-based monitoring requirements and procedures for aquaculture pollutants leading to the assessment of the environmental capacity of existing and planned coastal aquaculture operations,
- (2) preparation of review and guidance documentations for the safe use of chemicals in coastal aquaculture, and
- (3) the review of concepts and experiences related to the integration of aquaculture into coastal area management schemes.

In the past, the ICES Working Group has extensively considered pertinent monitoring issues. However, there is still a need to derive at purpose-oriented monitoring strategies.

The third term of reference is closely related to issues of central interest to the renamed ICES Working Group as interactions between aquaculture and the environment have not only biological aspects but also management implications where ever other human activities are involved and compete for the use of the same resources. Two Working Group Members (R. Gowen, H. Rosenthal) will be actively involved in the activities of GESAMP 31 in an attempt to closely link the work and harmonize efforts of both groups whenever key issues are addressed which are important to both groups

ICES Recommendations for the 1994 WGEIM meeting

Since the Working Group did not meet in 1993, the recommendations endorsed by the Mariculture Committee and adopted by the Council during the Statutory Meeting in 1992 under Council Resolution C.Res 1992/2:45 a-g should be reconsidered by the the Parent Committee at the 1993 Statutory Meeting for adjustment if necessary. Date and place of the 1994 WG meeting should also be identified at this meeting.

It is recommended that the Working Group meets for 4 days in April 1994 in Dublin, Ireland.

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