European Social Science Fisheries Network

FAIR CT95 0070

Multi-Disciplinary Research in Fisheries Management

Network Workshop 6
Sophienberg Slott, Denmark, 13-14 April 1999

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June 1999

Preface

The report presents the findings of the final workshop organised through the European Social Science Fisheries Network (ESSFiN) in compliance with the Concerted Action (FAIR CT95 0070). Throughout the earlier work of ESSFiN it had become increasingly apparent that the future for policy related research in fisheries lay in a multi-disciplinary approach incorporating the natural, economic and social sciences together with the cooperation of the fishing industry itself. Accordingly, the workshop was designed to explore the scope for further collaboration between the different disciplines engaged in fisheries research.

The domestic arrangements - in particular the excellent choice of venue overlooking the sound separating Denmark from Sweden - were undertaken by Peter Friis. Tragically, Peter did not live to see the fruits of his labours for he died suddenly less than two months after the meeting. It is quite certain, however, that all the participants - who contributed so positively to the proceedings - will cherish an affectionate memory of the occasion.

David Symes
Hull, June 1999

Contents

0.0 Summary

0.1 As a final task for the European Social Science Fisheries Network (ESSFiN) Concerted Action, a workshop was convened at Sophienberg Slott, Denmark, from the 12-14 April 1999 to explore the prospects for multi-disciplinary research in fisheries. Invitations were issued to individuals across a wide range of disciplinary and research experience and from different national backgrounds. Each participant was invited to review recent developments in their own disciplinary areas, to identify gaps in existing coverage and to indicate key themes for future research. The workshop was attended by 16 persons from five European and two North American countries.

0.2 Papers were prepared and circulated to all participants in advance. The programme was arranged in four sessions, three reflecting cognate disciplinary areas and a final session to discuss common issues. Participants made only brief presentations of their papers and each session was 'reviewed' by two or three named discussants. The report presents the papers in more or less their original, unabridged form together with a summary of each of the ensuing discussions. The summary focuses attention not on the papers *per se* but on the main points of discussion.

0.3 *Science and the environment*

It was clear that mono-disciplinary research is beginning to approach its limits both in terms of costs and its utility for fisheries management. An incremental shift is occurring from a narrow preoccupation with fish stock assessment to a much broader concern for ecosystem management; this assumes the appearance of a paradigm shift from utilitarian decision making and a commodity oriented mode of management to an incorporation of respect for nature, the multiple use of marine space and the value of non-commercial goods. The shift is also accompanied by advocacy of a move from centralised to decentralised management systems. These changes are essentially complementary and will have important repercussions for institutional arrangements and styles of management, with an implied switch from reactive to strategic management. Too much emphasis may have been placed on the traditional, science-led management framework in the past and on the development of very detailed micro-level scientific research when the needs of management are for meta- and macro-level information and advice. Science has been asked to bear too much responsibility for policy decisions in the past.

0.4 *Economic issues*

The presentations again pointed to an emerging paradigm shift which involves a move away from reductionism and formalism towards a more comprehensive or holistic mode of analysis of fisheries issues. The economic sciences are also insisting on the need to develop closer links between economic performance and the state of the marine ecosystem, human behavioural patterns etc., in much the same way as the biologists. However, the economic (and biological) sciences are facing a particular problem in that, while the completion of their research projects may take several years, management data (and even policy reform) demand very much shorter time horizons. Economic analyses tend to be preoccupied with cost efficiency but in a

relatively narrow sense; the emergence of an ecosystem approach requires that we begin to cost the ecosystem impacts of fishing in a much broader way. In fisheries, costing the environment is a difficult but important task.

0.5 *Social science perspectives in Europe and North America*

The social sciences are beginning to analyse and explain how the various actors within the policy community contribute to fisheries management. Recognition of the cognitive basis of management actions - including the notion that scientific advice is a social construct - is important. All actors reflect, consciously or otherwise, the contexts in which they are working. The emergence of powerful new actors - NGOs and lobby groups - which exploit opportunities to enforce policy change through litigation (as with the USA) provides an important field of analysis for the social sciences, as do the relationships between the fishing industry and the established (and newly emerging) power brokers within the policy domain.

0.6 *General discussion*

Multi-disciplinary research involves cooperation between disciplines in addressing common problems, but in a system where each discipline contributes directly through the application of its own epistemology, methodology and theoretical constructs. There is, therefore, little need for a separate theoretical construct embracing a multi-disciplinary approach, although it does require a much deeper level of understanding and respect for the conventions of the other disciplines involved. Multi-disciplinarity is more than simply a reflection of current intellectual fashion. It is a logical outcome of the complexities of fisheries management and the limitations of research and advice arising from discrete, mono-disciplinary research environments. Seen in this light, certain key foci for multi-disciplinary research can be identified, including risk assessment and the factors of uncertainty and unsustainability in fisheries management; the operationalisation of an ecosystem approach; and the analysis of alternative management systems, *inter alia*.

Increasingly close cooperation between research and management institutions may create problems in terms of the extent to which the research agenda is set by the management system and, therefore, the independence of the research findings. It is important to distinguish between the production of knowledge and the presentation of policy advice and to recognise that there may be tensions between the two. Possibly there is a role for the social sciences, with their tradition of independent criticism and a position largely outside the policy community, to assist in monitoring the research process.

0.7 *Conclusions*

In all disciplines there are opportunities to fine tune the research methodologies, identify new topics for investigation and improve the dissemination of research findings. But such intrinsic developments can only bring a marginal benefit to the management process. Possibly the greatest weakness of the current research system is that it remains fragmented, introspective and lacking in creative connectivity between

the participating disciplines. As a result, the value of the research contribution to fisheries management faces self-imposed constraints.

The development of new paradigms to model the fisheries system, its management and the research process will need to (a) broaden the objectives of fisheries management to include both ecosystem integrity and social equity; (b) develop longer term strategies for sustainable development; (c) tackle the issues of uncertainty and risk assessment; (d) incorporate relevant interest groups within the decision making system; and (e) face up to the political realities of fisheries management.

Central to the notion of a paradigm shift towards a more holistic form of fisheries management is the development of a multi-disciplinary approach to key areas of policy related research. However, this development is likely to face a number of institutional barriers within the research and policy communities created by entrenched values and threatened interests.

The European Commission, through the *Fifth Framework Programme*, can act as a vital catalyst in breaking down some of these barriers. Through the elaboration of its key actions and its insistence on a multi-disciplinary approach to many of these key actions, the Fifth Framework appears to signal an important shift in the nature of commissioned research. Realisation of this essential change will not be easy but the benefits of a broader approach to major issues within the domain of fisheries policy may be very considerable.

1.0 Introduction

One of the specific objectives for the ESSFiN Concerted Action is

> *'to review the current state of social science research relating to fisheries management in Europe and to identify key issues for future research'.*

It follows, therefore, that a key feature of the Final Report must be the development of an agenda for future research. There are many ways of addressing this particular challenge. We can, for example, rely very heavily on the conclusions from the sequence of workshops organised through ESSFiN and simply consolidate the list of recommended research topics identified in each of the reports (see Annex 1). However, these were framed not only within the specific frameworks established for each workshop but also almost exclusively within the context of the social sciences alone. An alternative source of information is the returns from ESSFiN members to our enquiry in the summer of 1998, concerning the shape and style of future research in the social science of fisheries and their management, which were reported in FINESSE No 10 (see Annex 2). Both are useful documents.

Throughout most of ESSFiN's proceedings, however, a majority of participants have shared a growing awareness that, as in many other areas of public policy, a true understanding of the key issues relating to fisheries management is unlikely to emerge from within any one research perspective, even one as broadly constructed as the social sciences. Instead what is needed is a balanced integration of all relevant scientific perspectives and the several research frames that inform each of these perspectives. Therefore, in anticipation of the need to structure recommendations for future research in a multi-disciplinary context, ESSFiN's concluding workshop (April 1999) brought together experts spanning a wide range of disciplines and backgrounds to present their own personal views on present and future research in fisheries. They were asked to review current developments in their own fields of research or experience, to identify any major gaps in the research output and to anticipate major shifts in the research agenda in the foreseeable future - identifying, where possible, the scope for multi-disciplinary research. The experts came from the biological, economic, political and social sciences; from government sponsored research institutes, universities, NGOs and from the fishing industry; and from seven North Atlantic States (five in Europe and two in North America). For want of a better way, the papers were presented in broadly defined disciplinary groups reflecting the biological and ecological sciences, the economic sciences and finally the social sciences (see Annex 3 and 4). Our intention to outline a multi-disciplinary research agenda; to identify the information needs and expertise to address this agenda; and to define the best possible means of securing a multi-disciplinary framework for collaborative research. In the event, we spent much of the time discussing a new paradigm of fisheries management.

The decision was taken to reproduce the papers in full with only minor textual editing: summaries, it was judged, would inevitably omit much that was important in both the argument and the supporting evidence. The following pages, therefore, present the papers prepared for the meeting in more or less their original form and the summaries

of two very full days of exhausting, but by no means exhaustive, discussion. The account is arranged in the standard form adopted for ESSFiN reports, namely

(a) the text of the papers, presented in their original sequence, together with an outline of the discussion following each group of papers;

(b) a summary of the final discussion session;

(c) conclusions and recommendations.

2.0 SCIENCE AND THE ENVIRONMENT

2.1 Making the transition from fish stock assessment to fishery management science

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Introduction

With the increasing overexploitation of fish stocks, there is a natural concern to manage the marine environment and harvest fish stocks in a sustainable way, whilst at the same time providing employment to fishermen and those dependent upon the fishing industry. Whilst there is a desire to evaluate the risks facing marine species (Pauly, 1980; Wainwright and Kope, 1998), failures in fisheries management have been linked to an inability to understand the inherent uncertainty of fisheries systems (Lane and Stephenson, 1998).

* Fisheries scientists must come to terms with what they can and cannot achieve.

Current themes in European fisheries

In fisheries, there is often a desire to operate in discrete, restricted areas for monitoring, assessment and management. The complexity of assessment methods is largely determined by the resolution with which catch statistics are recorded, and advice is typically restricted to recommendations on TACs (total allowable catches) and levels of fishing mortality (effort).

Conducting experiments in the marine environment is both economically costly and logistically difficult. The choice between management options cannot, therefore, be realistically approached through large-scale experimentation at sea. It is infeasible to test many options (i.e. treatments) and it is often impractical to propose the adoption of replicated experimental designs. Furthermore, it would be irresponsible to take risks with fish stocks and their fisheries, and with the livelihoods of fishermen and their families. Modern computing power, however, coupled with well founded analytical models and computer intensive simulation techniques, enables the conceptualisation of computer based models of the fisheries systems which it is intended to manage.

The evaluation of management options is best performed in the context of entire management procedures; that is, the combination of a particular stock assessment technique with particular control rules and their implementation (Anon., 1994). The approach is well established in the resource management context (e.g. de la Mare, 1985, 1986; IWC, 1993; Punt and Butterworth, 1995) and has been adopted in a variety of fisheries and regions (Francis, 1992; Restrepo *et al.*, 1992; Powers and Restrepo, 1993; Restrepo and Rosenberg, 1994; Punt, 1995).

- Fisheries science tends to be orientated towards the assessment of stocks rather than the management of fisheries.
- Fisheries management tends to be reactive rather than strategic.
- The consequences of management action are often deemed to be predictable.

Themes for future research

The range of acceptable harvest control rules that may be contemplated for a fishery and the way that these rules may be reflected in annual advice is restricted by various international agreements relating to the precautionary approach for fisheries management (United Nations, 1995a; Anon., 1996). Advice on harvesting within the ICES area is usually framed in terms of total allowable catches corresponding to multipliers of current fishing mortality. An ICES Advisory Committee on Fishery Management (ACFM) Study Group met in February 1997 (Anon., 1997) to design a form of advice consistent with the precautionary approach, as embodied in the *Code of Conduct for Responsible Fisheries* (United Nations, 1995b) and the *Agreement for the Implementation of the Provisions of the United Nations Convention of the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks* (United Nations, 1995a; 1995c). The study group suggested that ICES should explicitly consider and incorporate uncertainty about the status of stocks and their management in scenario modelling. In particular, thresholds should be proposed which ensure that limit reference points are not exceeded, and both fishing mortality rate and biomass limit reference points are required. The reliability of decisions taken can be measured directly by comparing the actual realisation of objectives with anticipated results. This feedback is crucial to the objective evaluation of the performance of management (Wilimovsky, 1985).

Advice from the ICES (Anon., 1998) ACFM will, in future, be constrained by F_{pa} and B_{pa}, the precautionary levels for fishing mortality and spawning stock biomass, respectively, which imply a high probability of remaining below and above F_{lim} and B_{lim}, respectively (see Figure 2.1.1). If F_{pa} were exceeded, then this would be regarded as overfishing and management would not be regarded as consistent with a precautionary approach. The development of a management plan to reduce fishing mortality to no greater than F_{pa} would then be advised. If no such plan were developed, ACFM would generally advise that management was not consistent with a precautionary approach.

If F_{pa} were set such that B_{pa} were unlikely to be reached, and since B_{pa} would be chosen to provide a high probability of avoiding recruitment failure, then if spawning stock biomass (SSB) were to fall below B_{pa}, advice to reduce fishing mortality would be likely. This would depend, however, on whether or not F_{pa} were being exceeded and on the prognosis for SSB trends in the most recent past and future, and the probability of recovering to above B_{pa} in the short term. If SSB were predicted to remain below B_{pa}, the development of a *recovery plan* would be advised.

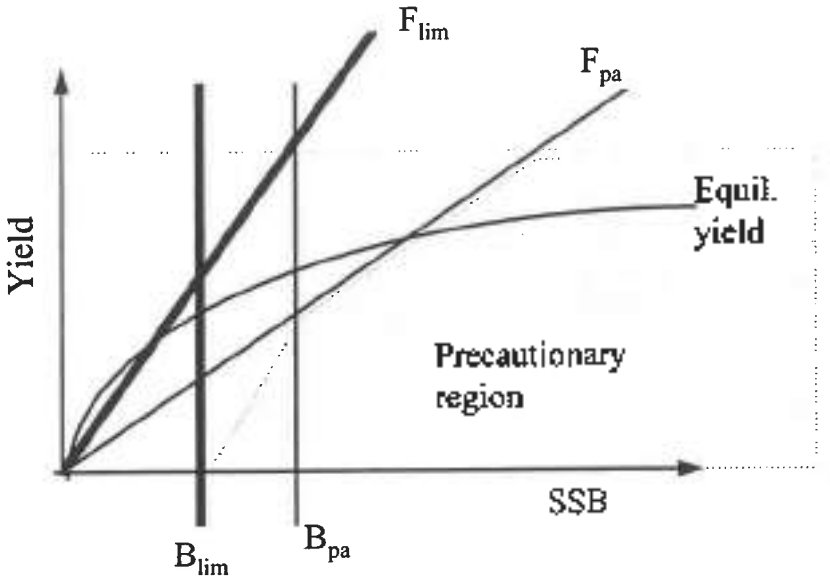

Figure 2.1.1: Use of fishing mortality and spawning stock biomass reference points within ICES to define a precautionary region.

Problems remain with the choice of suitable candidates for limit and precautionary reference points and with the estimation of uncertainty.

* There is a need for a much more proactive approach to fisheries management.

* The current separation into monitoring and assessment, and management, needs to be recognised. The strengths and weaknesses of each and their mutual dependency must be appreciated.

Gaps in knowledge of fisheries and management

There are many areas for which only partial (or incomplete) information is known.

* Models of fishery systems need to be improved and refined by collaboration between biologists, oceanographers, environmentalists, statisticians, economists and social scientists.

* Assessment methods often lead to inappropriate probabilistic statements; e.g. regarding the short-term and medium-term status of a stock.

* Uncertainty is seldom confronted.

The way forward

Future management should focus on integrated fisheries, rather than solely on fish populations, and will require an appropriate combination of biological considerations

with operational, social and economic considerations of the fishery (Stephenson and Lane, 1995).

* All methods of stock assessment permit only a limited range of management options (and questions) to be addressed and these must be elicited.

* An allowance for fishermen's behaviour must be incorporated into advice and management. This will necessitate collaboration with both economic and social scientists, although additional data may need to be collected.

* The social consequences of advice and management must be investigated and their impacts on employment considered.

* There is a need to identify suitable fishery ecosystems to study and to develop appropriate management tools.

* An inter-disciplinary approach is to be preferred to a multi-disciplinary one.

* Management objectives and viable management actions need to be discussed and agreed. This will necessitate wider collaboration with economists and social scientists, and possibly even with the implementors of policy.

* Appropriate time scales will need to be agreed both for the implementation of a proposed management procedure and for the evaluation of its utility.

* A science of fisheries management is required.

Note

This paper was prepared with funding support provided by the Ministry of Agriculture, Fisheries and Food (contract MF0316).

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2.2 The end of short-term prognoses or What constitutes valid biological knowledge as a basis for fisheries management?

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Introduction

In recent years we have witnessed three parallel and interrelated developments: in fisheries management an almost global failure of fisheries management to achieve its objectives - whether these be preservation of the resource base for fisheries, economic rationality or social targets; in the social sciences an expansion of the scope for discussions on fisheries management systems; and in the natural sciences attempts to incorporate new levels of complexity into prediction models. Social and natural scientists have reacted to the failure of management by a search for remedies within their own areas. The absence of attempts to understand the interrelationship of specific management systems and the natural science knowledge base, on which management is based, is striking. It is however imperative that any discussion of fisheries management addresses the science base of management.

The rationality context and crisis of fisheries biology

Any fisheries management set-up is based on institutions consisting of cognitive, normative and regulatory components. Discussions on fisheries management have focused on regulatory structures, to a lesser extent on normative aspects while the cognitive basis has hardly been addressed (Jentoft *et al.*, 1998). The implicit acceptance of the objectivity and adequacy of fisheries biological science, as we know it, by social scientists and the disciplinary blindness of fisheries biologists has led to a situation where discussions on fisheries management systems and the developments within fisheries biology are taking place almost independently. This is unfortunate as the present form of fisheries biology is closely associated with the development of a specific management regime - as any form of fisheries biology would be.

Modern fisheries biology has developed in close association with the emergence of a management system which can be characterised as centralised, based on numerical control of input or output parameters through top-down control structures, with an explicit emphasis on resource conservation. Contemporary fisheries biology provides the cognitive basis for this system through stock assessments, which basically are predictions of short- and long-term effects on stocks and yields given various scenarios of numerical regulation variables. The development of this management system and its cognitive base is a special case of general developments in social management, which characterises the incarnation of purposive rationality in the modernisation process and should be analysed and understood as such - in its historical and social context.

The rationality of social management in modern society has changed through optimisation (cf Weber) and social control (cf Habermas) to risk management (cf

Beck) in relation to the physical and biological basis for society. These changes are however developments within the same basic rationality - the purposive rationality *sensu* Weber.

Fisheries management and thus fisheries biology has developed accordingly - and remained within the same basic rationality. The goal functions of fisheries management have changed their emphasis from optimisation (yield maximisation, economic efficiency) to risk management and hazard control (precautionarity, maintenance of healthy ecosystems). Fisheries biology has developed prediction models as a basis for management, moving from the deterministic single species models developed by Baranov (1918) and expanded by Beverton and Holt (1956) with a strong emphasis on yield optimisation to inclusion of species interaction effects (Andersen and Ursin, 1977), ecosystem impacts (for instance ICES Working Groups on the ecosystem impacts of fisheries) and risk assessment models (as implemented by ICES in recent stock assessments - ICES, 1998b) (Fig 2.2.1).

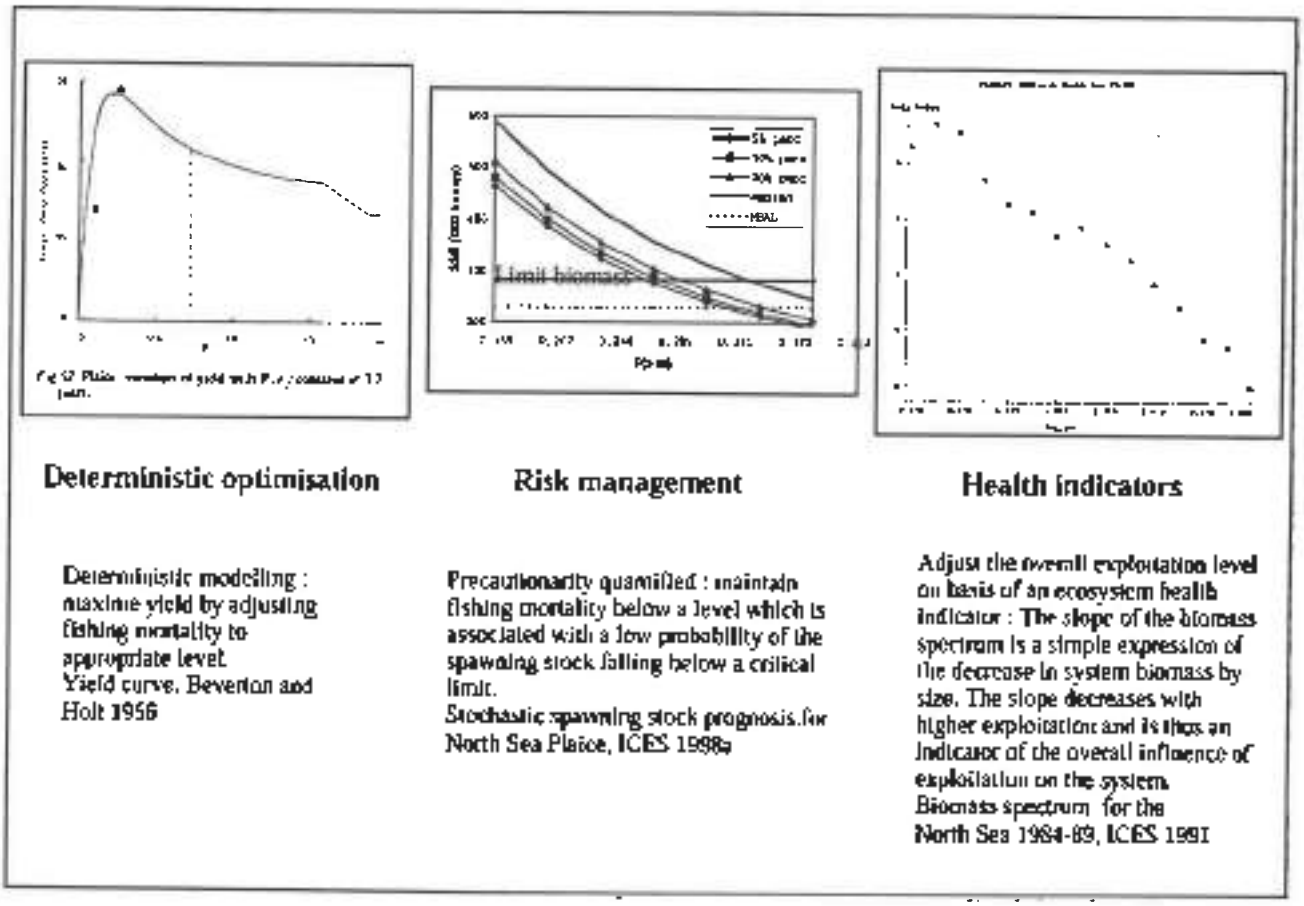

Figure 2.2.1: Models in fisheries biology and management - from deterministic numerical predictability through stochastic predictability to health indicators.

These developments in management and fisheries biology are basically within the same paradigm - quantifiable objectives can be set and fisheries biology can provide quantitative models which will quantify the regulatory parameters in relation to quantifiable objectives.

The regulatory instruments are, obviously, reflections of the basic rationality and the cognitive basis. Most contemporary management systems rely on TACs in one form or another and such systems are prime examples of social management relying on the ability of science to provide instruments to establish quantifiable objectives and means for the short term. The requirements are real time knowledge of the state of the system and predictive models.

The recent transformation from optimisation to risk minimisation represents an attempt to internalise a fundamental problem in the prevailing management system. The addition of stochasticity and ever more complex models in the transformation from optimisation to risk minimisation and in the inclusion of ever more complex goal functions does not represent a durable solution for two reasons: cost and chaos (Fig. 2.2.2).

* Cost: the marginal costs of adding another component to the models, another goal function etc. are becoming prohibitive in terms of the data needed to support such models and model complexity.

* Chaos: there are principal limits to the predictability of any natural system beyond which it is impossible to assemble sufficient detailed data and models to provide any reliability (Wilson *et al.*, 1994).

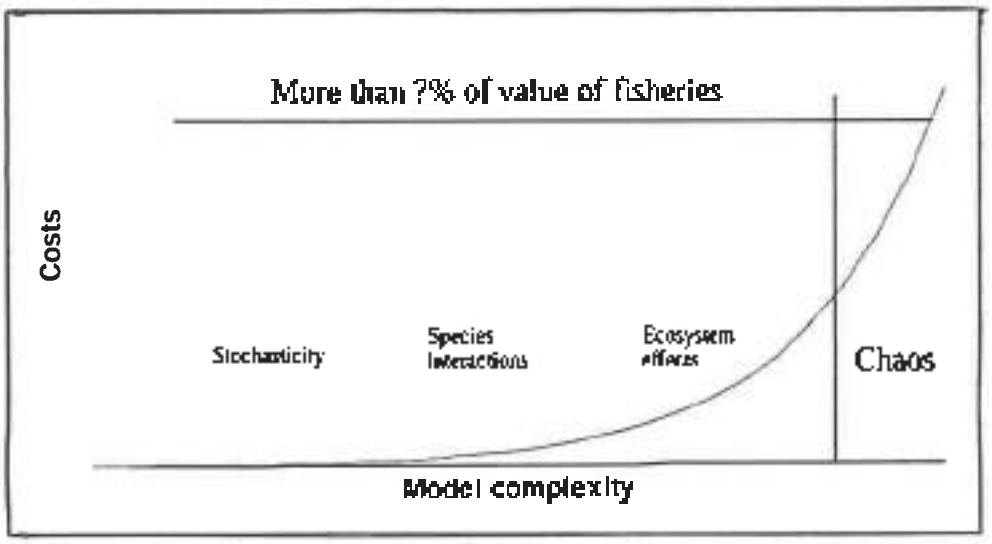

Figure 2.2.2: Model complexity and costs are related. The model complexity which can be afforded within a management system is ultimately limited by costs and chaos.

These limitations are limitations *within* fisheries biology, limitations solely within the cognitive domain of management. There are other limitations to this management rationality related to normative and regulatory aspects. The acceptance of the cognitive basis for management is an important issue here - what is the validity of the cognitive base amongst those who (in this type of set-up) are managed? This issue is complex; it is not simply a question of inverse proportionality between the complexity of knowledge and social acceptance, but rather a question of contemporary fisheries biology, with all its recent add-ons of complexity, being developed as the technical tool within centralised top-down management and reflecting this management structure and its ambitions of social control.

The development of fisheries biology is thus associated with two problems:

* Fisheries biology is approaching the limits of cost efficiency relative to the value of fisheries - and can still not deliver the goods in terms of numerical predictions.

* The models and concepts of fisheries biologists are becoming increasingly alien to stakeholders - stakeholders are losing ownership, to the extent that they ever had ownership.

The result is that contemporary fisheries biology is facing a crisis on several levels:

* Fisheries biology does not deliver a knowledge base for fisheries management which is considered valid by stakeholders – loss of legitimacy.

* There are no solutions directly as extensions of present paradigms - more of the same is exactly what has created the problems in the first place.

* An extension of present paradigms will furthermore be limited by rapidly escalating costs.

There is thus an urgent need for a new paradigm in fisheries biology which is cost efficient, provides knowledge which is considered valid by stakeholders and which is able to deliver. However, due to the close association between the form and content of management institutions and their cognitive base, a new paradigm cannot be defined from within fisheries biology itself. The present problems are not generated from within fisheries biology but are a necessary and unavoidable consequence of the management context within which fisheries biology is operating. The future of fisheries biology can only be identified on the basis of new management paradigms based on another rationality.

Ongoing research in fisheries biology in relation to future needs

Contemporary research in fisheries biology is mainly occupied with developments within the basic paradigm of quantitative predictability:

* Inclusion of *stochasticity* in analytical and predictive models. Stochasticity is introduced in terms of both data and model uncertainty.

* Addition of *complexity* - multispecies, other biota (birds, sea mammals), lower trophic levels, finer spatial and temporal resolution.

* Adoption of *new goal functions for predictions* - ecosystem effects of fisheries, precautionarity (which is transformed into risk management by quantification).

* *Improvements of estimation and prediction models* - solutions to technical estimation problems mainly to accommodate stochasticity, complexity and new objectives but also to utilise more advanced statistical approaches made possible by development of computer capacity.

There are also various lines of research, which may point in other directions (see Fig. 2.2.1):

* Development of stock health indicators (SSB limits, age structure, spatial distribution).

* Development of ecosystem health indicators (size spectra, trophic structure, indicator species sensitive to exploitation).

These lines of research may support management systems, which address some of the problems identified above. The development of indicators is one way of dealing with the internal limitations of cost and chaos. However, these new lines are presently not developed in a specific management context.

Major themes for future research

From the point of view of a fisheries biologist, there is an urgent need to clarify the relationship between management systems and their cognitive base. The main problem in identifying future research in the natural science aspects of fisheries is that most agents - including natural and social scientists and management bodies - basically operate on the basis of an understanding that the natural science component of fisheries management is an objective basis with methodology and subject choices being independent of management. Future research themes cannot be identified on this basis. It is therefore an important research theme in itself to understand the interrelationship between the natural science base and specific management systems. Given the presently dominating management set-up it is also an important research issue to identify the limits within fisheries biology - cost and chaos - for numerical predictability. Important research themes would thus be to:

* Identify limits to mainstream reductionism due to principal limits to numerical predictability about marine ecosystems.

* Identify limits to mainstream reductionism within the present management context - are imprecise numerical predictions partly useful or may they lead to mismanagement?

* Identify new management paradigms - and on this basis develop appropriate fisheries biology.

New management paradigms which would circumvent the dependence on numerical predictability could be based on stock and ecosystem health indicators. Indicators are generally numerical, but they represent soft predictability. A management system based on health indicators cannot therefore rely on regulatory structures, which are dependent on short-term predictability such as quotas. Management based on indicators could for instance involve an adaptive management regime, regulating the overall impact of fisheries on the marine ecosystem by regulation of the impact potential through longer term capacity and effort adjustments and adaptation on the basis of indicator monitoring. Some regulation of 'how, where and when' (gear restrictions, no take zones etc.) could be used as precautionary supplementary measures within such a regime to address specific concerns, and it should be possible to establish a cognitive base for such regulations without reverting to requirements for extensive short-term predictability. However, even if such a regime would reconcile the cognitive and regulatory bases for management, there is still a long way to go before the all important aspect of social acceptance is resolved. The development of new management paradigms must obviously address all these issues simultaneously - they must be based on multi-disciplinary research.

Existing gaps in knowledge of fisheries and management

The main issue concerning gaps in knowledge is not gaps *per se* but an approach which neglects important interrelationships between various aspects of fisheries management. This approach will result in inherent gaps, but the solution is not gapfilling but an understanding of the interrelationships. It is thus an issue in itself that the social sciences (including economics) appear to trust the products of mainstream reductionist fisheries biology - even more than the biologists themselves - without realising that fisheries biology as we know it simply reflects a specific system for social management. There is thus a research issue in clarifying this relationship.

One of the most important gaps in our knowledge is the lack of understanding - or even reflection - on the validity of the cognitive basis for management. Any management system relies on some knowledge - from mental models to numerical short term predictions - of the fisheries and their resource base. In the present management system this knowledge is produced by specialised institutions which are an integral part of centralised management institutions, and the knowledge on which management is based is to a large extent not accepted as valid by the fishing industry or by other stakeholders such as environmental NGOs. Any rethinking of management must include consideration of what constitute criteria for validity of knowledge within a specific management set-up.

Rethinking fisheries biology through inter-disciplinarity

In summary, it can be concluded that inter-disciplinarity is a condition for establishing criteria for valid fisheries biology - and for fisheries management systems in general. Core questions which should be addressed through inter-disciplinary research are:

* Within the present management set-up: what are the limitations in terms not only of its efficacy in meeting objectives but also in terms of transaction costs (including supporting science) and the basic paradigm of predictability within purposive rationality *vis-à-vis* complex ecosystems and multiple objectives?

* In general: there is a need for an evaluation of the cognitive basis of various management systems in relation to scale, institutional capacity and user empowerment. What are the criteria for valid knowledge in a specific management context - valid knowledge is understood as knowledge which is considered legitimate and with ownership by the stakeholders?

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2.3 Effects of fishing on non-target species and habitats: key issues

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Introduction

Our knowledge of the effects of fishing on marine ecosystems and their fauna and flora has increased considerably over the last decade. This considerable research effort has culminated recently in at least five important conferences or workshops that have specifically considered these issues. The outcomes of these meetings are the basis for my synthesis of key issues concerning the effects of fishing on non-target species and habitats.

We have now moved beyond the first stage of quantifying the immediate changes that occur as a result of benthic disturbance, or calculating the numbers of fish, birds or mammals caught as bycatch (Jennings and Kaiser, 1998). Inevitably there is still some work required to fill in some gaps in our knowledge and for the purposes of monitoring the effects of fishing on the ecosystem. More importantly, we have now advanced to a position where we are able to calculate the effects of fishing in terms of population changes that occur at scales relevant to environmental and fisheries managers. Such information has enabled us to predict the likely consequences of modifying fishing practices for populations of species that depend, to some extent, on fishing activities as a source of food. At a recent meeting in North Wales, UK, invited presentations gave a state of the art view on our current level of understanding of the ecological consequences of fishing in European waters (Kaiser and de Groot, in press). It was encouraging to note that similar scientific studies and conclusions are beginning to emerge elsewhere in the world (see Jennings and Kaiser, 1998, for review). In the present paper, I highlight important issues that relate to the consequences of fishing activity for non-target species, seabed biota and seabed habitats.

Distribution of fishing effort and physical interaction with the seabed

While it is important to be able to quantify the direct effects of fishing disturbance on the seabed, it is equally important to know the location of the main areas of the sea that have been and are presently affected by fishing activity. Prior to 1993, the only indication of the distribution of fishing effort was based on the data collected for each International Council for the Exploration of the Sea (ICES) statistical rectangle. While these data have been collected for many years and might permit the construction of historical patterns of disturbance for specific relatively large-scale areas of the seabed, they have always been treated with care due to problems associated with misreporting. In addition, these data are collected at such large scales that they lack the resolution relevant at the scale of benthic habitats, hence it is difficult to make realistic predictions as to the likely changes that may have been induced by bottom fishing. Furthermore, individual national datasets are limited in their use when many areas of the North Sea are fished by several countries, yet there is still no official scheme to systematically compile international data. Clearly we need a centralised system of

fishing effort data collection that maintains national anonymity if necessary. Then, in 1993, black box recorders were fitted to a proportion of the Dutch beam trawl fleet. The data yielded from this study have demonstrated how patchily fishing effort is distributed at a scale as small as 9 km² and that these data are only truly representative of a homogeneous distribution of effort at a scale of 1 km² (Rijnsdorp *et al.*, 1998). However, while the data provided a great insight into present day fishing effort patterns, it is limited in the extent to which it can assist our understanding of the distribution of historical fishing effort. Furthermore, the data pertains to only one fishing fleet in the North Sea. Jennings *et al.* (in press) have examined overflight data collected by government agencies that have recorded the precise location of fishing vessels while working at sea. The overflight data suggest that fishing effort data collected for ICES rectangle give a good representation of the general distribution of fishing activities, but as reported by Rijnsdorp *et al.* (1998), provide no indication of the micro-scale distribution of fishing within each area. While the large-scale distribution of fishing effort may be suitable for studies of changes in highly mobile species such as fish, it lacks resolution for the finer scale analyses relevant to the study of benthic biota (Ramsay *et al.*, in press; Craeymeersch *et al.*, in press). All fishing vessels should be fitted with tracking devices for the purposes of environmental management. This would aid any future implementation of closed areas, but equally, it may dispense with the need for the latter in some cases.

Bottom fishing trawls are designed to remain in close contact with the seabed and an inevitable consequence of their design is the penetration and resuspension of the seabed to some degree. While it appears possible to reduce the direct physical forces exerted on the seabed by modifying fishing practices (e.g. towing with or against the tide), the net benefits are questionable and catches of commercial species would almost certainly suffer (Fonteyne, in press). In the case of beam trawls, there is no doubt that the tickler chains or chain mats are the part of the gear responsible for causing the majority of physical disturbance and damage to fauna. Van Marlen (in press) offers some insights into the possible methods for replacing tickler chains with supposedly less damaging devices such as an electronic tickler chain. Nevertheless, as van Marlen acknowledges, such gear adjustments are likely to be of limited benefit to benthic fauna and habitats, although their contribution should be seen as a positive step. Despite attempts to improve gear design, as long as we continue to pursue bottom dwelling species using towed fishing gears there will be inevitable sediment resuspension. The biological and geochemical implications of the resuspension of sediments caused by fishing activities is poorly understood but may be significant (Churchill, 1989). One likely consequence of increasing the suspended fine particles in the water column is the reduction of light available for photosynthetic organisms. Increased turbidity will have greater ecological significance in waters that are normally relatively clear (e.g. sea lochs, fjords or open coasts) compared with shallow areas that are highly perturbed by physical forces and subject to riverine discharges (e.g. the southern North Sea). Ardizzone *et al.* (in press) investigated whether this might be one of the causes of seagrass regression in the Mediterranean Sea. Their results indicated that increased turbidity increases seagrass regression close to riverine discharges. However, there was no evidence of increased sediment resuspension in areas trawled illegally and regression occurred patchily within the seagrass bed and was not related to depth. Hence, in this case, it was concluded that the direct physical disruption of the seagrass on the seabed was the cause of regression and not sediment

resuspension. The prognosis for minimising damage to the seabed from towed bottom fishing gear is limited. Several alternative management solutions are possible: ban fishing with towed bottom fishing gear; restrict fishing with towed bottom fishing gear and encourage the use of alternative techniques such as netting or trapping; accept that certain areas of the seabed will remain in an altered state as long as we continue to eat species captured using towed bottom fishing gear (i.e. damage limitation).

Effects of fishing on benthic fauna and habitats

Previous short-term experimental studies of the effects of fishing on seabed communities have been limited to quantifying immediate or short-term changes. Yet the fundamentally important question is whether the populations of the affected organisms can sustain current levels of disturbance, or whether they are likely to suffer population declines. Bergman and van Santbrink (in press) are the first to have quantified the absolute mortality rate of benthic biota that encounter bottom trawls. They found that the annual mortality rate of some species is up to 39% which is less than the annual fishing mortality of plaice in the North Sea. However, our knowledge of the biology of many of the benthic biota is limited and in many cases we can only estimate whether or not a species is likely to suffer critical fishing mortality rates (MacDonald *et al.*, 1996). Perhaps the best example of such a species is the common whelk. Whelks mature at an age of about 5 years, lay their eggs in batches on the seabed on hard substrata, and are more vulnerable to predation after they have been in physical contact with a trawl (Ramsay and Kaiser, 1998; Mensink *et al.*, in press). Whelks have been absent from the Dutch Wadden Sea for many years and the evidence published to date suggests that bottom fishing is almost certainly responsible. Current data strongly suggest a decline in the benthic fauna of certain intensively fished areas of the North Sea - but as far as we know no species are threatened with extinction.

Many of the previous studies of the effects of fishing on benthic biota in the North Sea have been hampered by the lack of suitable control areas that have remained unfished. The value of a closed area as a comparative tool for such studies is illustrated by Bradshaw *et al.* (in press) in their study of the effects of scallop dredging off the Isle of Man. Similarly, Ball *et al.* (in press) used wreck sites as reference points against which the fauna of heavily fished areas were compared. Both of these studies provide strong evidence that chronic fishing disturbance has altered benthic community composition with time. The closed area off the Isle of Man has permitted Bradshaw *et al.* to observe changes after the closed area was instigated. It appears that the benthic communities in the closed area became more heterogeneous after the cessation of fishing. They were then able to conduct an experiment that demonstrated that it was possible to reverse this trend and drive the community within the closed area back to a condition found in heavily fished areas. The habitats examined in these two studies are either mud or coarse sediments that are eventually restored with time. Habitats constructed by or composed of living organisms are likely to take much longer to recover. These biogenic habitats are unusual and have limited distribution. Hall-Spencer and Moore (in press) draw attention to the effects of scallop dredging on maerl beds that are composed of the thalli of very slow growing (< 1 mm y^{-1}) plants. Scallop dredging is highly efficient in these habitats, so almost the entire stock of

scallops is removed after one or two episodes of fishing. The authors clearly demonstrate that recolonisation by the biota and regrowth of the plants in this habitat will take > 5 y as a result of just one passage of a gang of scallop dredges. It is quite clear from this study that the short-term gain derived from fishing such a habitat does not justify the environmental damage caused. This is the clearest case of a marine habitat that should be protected immediately from the effects of towed bottom fishing gear. While we still do not understand the functional significance of high diversity habitats such as maerl beds, it may be necessary to compensate fishers to refrain from fishing them and perhaps engage fishers to protect these habitats long enough for us to understand their ecological role in more detail. Furthermore, unpublished data suggest that it is possible to predict recovery rate for different types of habitat. This unpublished study indicates that soft sediment habitats may be able to sustain 3-4 disturbances per year, whereas disturbance is clearly unsustainable in biogenic habitats (Collie, Hall, Kaiser and Poiner unpublished data). We now have enough biological information to advise managers that bottom fishing with towed mobile gear is unsustainable in habitats that are formed by biota (e.g. mussel and maerl beds, coral and sponge reefs).

Fishing as a source of energy subsidies

Bottom fishing directly alters the composition and structure of seabed communities and habitats. In addition, fishing redirects energy within the marine ecosystem via two routes. Firstly, animals damaged, killed or displaced on the seabed become available for consumption by benthic and demersal predators and scavengers. Secondly, material hauled onboard fishing vessels and then discarded overboard is available to avian and midwater predators and scavengers. Demestre *et al.* (in press) demonstrate that benthic and fish scavengers aggregate in areas of trawl disturbance on a muddy Mediterranean seabed, and as in previous studies all the available food appears to be consumed within 72 h. Hence the potential benefits are short term unless these subsidies are sustained by an intensive fishery. Fonds and Groenewold (in press) have taken data from Bergman and van Santbrink (in press) to calculate the total amount of food potentially generated by trawling in the southern North Sea. Using data derived for the energetic requirements of selected scavenger species at different times of the year, they have calculated that the additional energy generated by fishing activities is only enough to provide 7% of the maximum food demand of the entire scavenger population in the Dutch sector of the southern North Sea. These data suggest that, on average, there is insufficient material to stimulate an overall population expansion in scavenging species. Such signals, if they occur, might be manifested most clearly in populations of starfish that are highly resilient to the adverse effects of fishing and are able to eat a wide range of different food types. Ramsay *et al.* (in press) related starfish abundance in the southern North Sea and English Channel to trawling effort. In both cases the response of the starfish populations is similar, i.e. at relatively low to medium levels of fishing disturbance starfish populations tend to increase, whereas at the highest levels of fishing disturbance, the negative effects of fishing (i.e. starfish mortality) outweigh the benefits derived from energy subsidies. What is clear from this study is that while energy subsidies may affect starfish populations there are many other factors that have much stronger influences on the population fluctuations of this species. In contrast, previously it was thought that the increases in the population size of many avian scavengers was largely related to increases in the amount of fisheries

generated waste. However, Camphuysen and Garthe (in press) emphasise that seabirds remain reliant upon natural sources of food that are vulnerable to overexploitation by humans or periodic population collapse due to unforeseen natural phenomena. Fisheries wastes may have aided the expansion in the range of some species by providing a guaranteed source of food when alternatives were unavailable. While seabirds are not entirely reliant on fisheries waste as a source of food, sudden changes in the distribution of fishing effort (that might relate to the instigation of areas closed to fishing) or fisheries policy (relating to mesh-size regulations) could have unexpected side effects for seabird populations. It is unlikely that populations of benthic scavengers are strongly influenced by energy subsidies from fishing activities; nevertheless, these species may eventually predominate in areas of intensive fishing.

Long-term changes associated with fishing

We have seen that fishing alters the seabed habitat, directly affects the animals living within or on the substratum and may indirectly influence populations of scavengers. Craeymeersch *et al.* (in press) have investigated the cumulative effects of many years of fishing disturbance by comparing the composition of benthic fauna in areas subjected to different intensities of fishing effort. While the distribution of fauna was correlated with the latter, fishing effort was only one of many variables that explained the observed patterns of community data. Nevertheless, fishing effort was highly correlated with the occurrence of opportunistic spionid worms that were most abundant in heavily fished areas. One of the problems faced by any scientist working in the North Sea is that this area has been subjected to human impacts for many hundreds of years, hence the present day fauna is likely to be the product of human interference and environmental changes. This point is emphasised by Frid and Clark (in press) who have used historical records of benthic community data to tease apart the different influences of environmental and fishing effects. As they point out, the greatest changes associated with bottom fishing in the benthic fauna of the North Sea probably occurred some years ago with the removal of long lived and reef forming fauna. These organisms are intrinsically the most vulnerable to physical disturbance and are likely to be the first to disappear from a physically perturbed environment. Greenstreet and Rogers (in press) develop these ideas further for non-target species of fish. As for benthic species, current applied theory indicates those specific life history characteristics likely to make a species vulnerable to fishing disturbance. These life history characteristics include large ultimate size, slow growth rate, and greater age at maturity. Greenstreet and Rogers examine elasmobranchs in detail as they are a group of species which have such life history characteristics likely to render them susceptible to fishing disturbance. In general, trends in the abundance of the different shark, skate and ray species in the North Sea can be attributed to fishing mortality since they follow predictions based on the life history characteristics of each species (Jennings and Reynolds, in press). This contrasts with the case of the Georges Bank where skate and dogfish abundance has actually increased, probably because they were always discarded, and likely to have a high survival rate following discarding. Whilst fishing undoubtedly causes increased mortality for many non-target species, in some cases, it may also increase the scope for population growth through scavenging and reduced predation and competition. It is clear from the studies reported at the workshop that long-term changes in populations of animals are much more clearly seen in large bodied organisms such as birds and certain fish species and become

gradually less clear at lower trophic levels and for smaller body sized organisms. The links between fish and invertebrate diversity and the stability and productivity of marine communities are unknown. Hence, we need to improve our understanding of the pattern and processes involved with marine ecosystems so that we can better determine fishing effects. The use of diversity indices may not reveal the subtle shifts associated with the effects of fishing which are more readily determined using multivariate techniques that have the ability to highlight changes in indicator species or functional groups of organisms (Jennings and Reynolds, in press).

Conservation methods, issues and implications for biodiversity

Improvement of gear technology certainly has a role to play in the conservation of both target and non-target species. Improvements in mesh configurations and gear design and the use of pingers show promising signs of alleviating some of the bycatch problems that are exhibited throughout the fishing industry (van Marlen, in press; Tregenza, in press). Nevertheless, improvements in gear design have only limited potential to reduce bycatch problems and may yield conflicting outcomes. For example, while gill nets are highly selective for certain size classes of fish, they are associated with undesirable bycatches of cetaceans (Tregenza, in press). No improvement in gear designs will address the problem of seasonality and locality of bycatches. Tregenza (in press) suggests that some cetacean species are more vulnerable to interactions with fishing gear in certain seasons. Hence, in addition to the use of pingers on set nets, bycatches might be reduced even more effectively if certain areas of the sea were free of set gears at certain times of the year. The behaviour of cetaceans in respect to nets is complex and needs more detailed study to improve our ability to conserve these species in an environment that supports set net fisheries.

Tasker *et al.* (in press) highlight key conservation issues that pertain to the widescale effects of fishing on the marine environment. There is now an agreed strategy among North Sea nations to ensure sustainable and healthy ecosystems in the North Sea (Anonymous, 1993). This might be achieved by defining best current fishing practices, or improving existing techniques or perhaps vetting proposed new fishing methodologies. In addition, Tasker *et al.* suggest the need for the definition of appropriate levels of fishing mortality for non-target species and acceptable levels of habitat disturbance. In the case of maerl communities we would conclude that towed fishing disturbance is unacceptable, whereas highly perturbed sandy seabeds would be expected to be more tolerant of increased perturbation. Finally, they suggest the establishment of No Take Zones (NTZs) to ensure ecosystem integrity. While there is little evidence to suggest that NTZs are a realistic mechanism to conserve commercial fish stocks in temperate waters (Horwood, in press) they are unlikely to worsen the current situation. They may have some benefit for more sedentary species that remain confined within the limits of the NTZ (e.g. scallops). Nevertheless, their value in terms of preserving examples of different habitats that may be valuable as breeding or nursery grounds is widely supported; indeed the UK currently has many such closed areas (although these are not true NTZs). Our current inability to disentangle the effects of fishing from environmental changes that have occurred in European waters is partly attributable to a historical lack of NTZs that would provide true control areas for experimental and comparative studies (Lindeboom, in press). The scientific value

of having areas closed to towed fishing activity is clearly demonstrated by Bradshaw *et al.*'s study (in press). Not all methods of fishing are equally damaging, hence there is scope for a suite of zoning schemes that permit use of certain gears but not others (Tasker *et al.*, in press). It should also be recognised that the essential aims of a more environmentally friendly management of fisheries is to ensure a long-term future of the fishing industry. However, as experience has shown, regardless of the good intentions of these objectives they are unlikely to be realised if we do not begin to develop NTZs and similar schemes with the full participation of the fishing industry (Lindeboom, in press).

Socio-economic implications and mechanisms for reducing fisheries impacts

The emphasis of the paper thus far has been centred on the repercussions of fishing activities for marine habitats and biota and the mechanisms of minimising these effects. As a marine ecologist, I have been aware that it is easy for those of us that study the biological aspects of fishing activities to become so engrossed in this pursuit that we are guilty of forgetting the social implications of some of our recommendations. It is easy to argue the creation of a NTZ on biological grounds without considering the impacts that this may have for fishers that currently exploit this area. Similarly, imposing bans on certain types of gear will have drastic economic consequences for those fishers that have invested heavily in this particular fishing sector. This final section of the paper is designed to highlight the complexity of implementing marine conservation objectives when this is likely to cause immediate and perhaps indefinite reductions in the income of the industry.

The main objective of fisheries management is to ensure the sustainability of the commercial stock, and while many methods have been tried, none have proved entirely successful. Individual transferable quotas (ITQs) were designed to alleviate problems associated with discarding. However, Pascoe (in press) demonstrates that, in many scenarios, ITQs can result in an increased tendency to discard fish that are above the minimum legal landing size. However, under an ITQ system, a fisher is better able to plan the harvesting strategy. This could result in a fishing pattern that lowers discards but this depends on the spatial distribution of the stock. In addition, the incentives to adopt more selective gear are also increased. Hence, while a greater proportion of the catch of small fish may be discarded, less small fish may be caught and hence overall discards may be lower. Even in unmanaged systems there is a tendency to discard fish due to constraints such as a vessel's fishhold capacity. Fishers are sophisticated predators that alter their behaviour to maximise their net financial gain. The techniques employed by Pascoe give us a useful insight into the likely outcome of adopting one of a number of conservation strategies and how fishers might adopt their behaviour to compensate the effects of legislative restrictions. The techniques used by Pascoe have great potential if we are to evaluate the financial incentives necessary to encourage fishers to support the implementation of NTZs and how this might alter their subsequent fishing behaviour.

McGlade and Metuzals (in press) report a detailed case study of the governance required and options that might be implemented to reduce bycatches of harbour porpoises. They have supplemented existing information on porpoise catches by interviewing fishers involved in set net fisheries which proved to be an extremely cost

effective method of assessing levels of bycatch. They were then able to undertake a spatio-temporal analysis of fishing effort by fleet and for individual vessels, in relation to oceanographic features, with information gathered from interviews and previously published studies. Their results demonstrated a high coincidence of porpoise bycatch with seasonal patterns of fishing effort for cod that are associated with fronts in the southern and central North Sea and with tidal mixing in the summer along the inner waters of the Danish coast. Technical factors specific to the fishing operations such as the height of nets and long soak times in deeper waters were also important factors that influenced bycatch. This detailed understanding of the interplay between the environment and the behaviour of fishers made it possible to analyse the governing needs required to support a code of conduct for responsible fisheries. It was concluded that fishing practices, price competition and a lack of participation in decision making often led to situations where bycatches occurred. Changes to the administrative and market structures were considered necessary for these fisheries to remain sustainable. When interviewed, fishers recognised the need for technical measures and responsible fishing practices and suggested that these should be policed by a self-governing body. These net fisheries are essential to the survival of a number of local communities and it is important that we seek to implement management systems that continue to permit the fishers to pursue their living while seeking to minimise any associated adverse effects. However, many of the measures suggested would seem to erode current profitability margins by causing fishers to alter gear and fishing practices. Given current consumer awareness and preference for 'dolphin friendly' tuna products, it is to be hoped that the deficit in profitability can be subsidised by consumer demand.

Jones (in press) discusses the problems associated with public (societal) perception of the marine environment and its inhabitants. While flagship species such as cetaceans and turtles evoke public condemnation of activities that might threaten these animals, they have perhaps deflected attention away from other priorities, such as the changes that have occurred lower down the food chain (Pauly *et al.*, 1998). Scientists need to become more actively involved in the education of the public and decision making processes which would help to focus research and increase its general impact. The uncertainties surrounding our current knowledge and ability to predict the widescale effects of fishing on the marine environment do not enhance our scientific credibility. There is clear scientific justification to set up areas closed to fishing to protect certain vulnerable habitats such as maerl beds. We should now present this information to the fishing industry and in joint consultation publicly present a policy on the agreed management practices for this particular habitat. From the fishers' perspective this may seem yet another attempt to reduce their access to areas of the sea, yet it must be emphasised that the essential aims of a more environmentally friendly management of fisheries is to ensure a long-term future for the fishing industry. Furthermore, these vulnerable habitats are by definition rare and as such would not involve any great loss of accessible area to towed gear fisheries and can still be exploited by fishers using less intrusive gears such as pots and set nets.

Conclusions

There is now an overwhelming literature that demonstrates the undoubted influence of fishing on our marine ecosystem. Mechanisms and strategies exist that might be implemented to reduce these effects while still exploiting marine species. However,

unless public concerns or fishers demand that action is taken there is little incentive for governments to act. Research may become the alibi of government procrastination, as a cynic would allude to the current research project culture that runs for three years with a further extension of another three years, by which time the problem has become that of the next political party in office.

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2.4 A multi-disciplinary approach to research on fisheries and marine wildlife, with special reference to seabird populations

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Introduction

The pivotal role of fisheries in the context of sustainable use of the marine environment and maintaining its biodiversity is being increasingly addressed in international fora and agreements. This is causing us to review the way we manage and research fisheries. In the European arena, a major spur has been the Intermediate Ministerial Meeting (IMM) on the Integration of Fisheries and Environmental Issues (Bergen, 1997). The IMM *Statement of Conclusions* underpins three principles that will undoubtedly shape multi-disciplinary research for fisheries management in the years ahead, namely commitments to - respectively - sustainable development, application of the precautionary approach, and lastly definition and development of the ecosystem approach.

Against this benchmark of guiding principles, I will describe major current themes in research on integrating management of fisheries (mainly finfish) and the marine environment (highlighting seabirds), indicate how these should be developed in future, identify gaps in knowledge for multi-disciplinary research, and indicate how these might be filled. In the last section, I will address the role of the NGOs in the system, and the framework in which this multi-disciplinary research has to operate.

The Royal Society for the Protection of Birds is a UK non-governmental organisation, with over a million subscribing members, which seeks to conserve birds and their habitats. The RSPB advocates fisheries management that restores and maintains the balance between fishing effort and living marine resources, thus ensuring the long-term sustainability of fish stocks and a more stable ecosystem for seabirds and other marine biodiversity. As UK partner of BirdLife International, the RSPB plays a key role in delivering science based advocacy to the fishing industry, its managers and administrators in Europe and beyond.

Relationship of seabirds to fisheries

Seabirds are among the most significant top predators in marine ecosystems, not just numerically but as indicators of changes, both natural and man induced. North Sea populations of marine birds are among the best studied in the world and can help to inform global issues of managing fisheries in a way sensitive to the wider marine environment. Over 4 million seabirds breed in and around the North Sea coast in summer. In winter, similar numbers forage in the region but the species composition is different due to seasonal migrations (Dunnet *et al.*, 1990). Additionally in winter half a million seaduck use coastal waters and several million migrant waders occupy the intertidal zone.

For most seabirds, life ashore is a close encounter of the brief annual kind, representing only a fraction of their total lifespan (which may last 30 years or more, according to species). The vast majority of their lives is spent not at breeding colonies but offshore, well beyond national territorial waters. North Sea seabirds have been estimated to consume ca 600,000 tonnes of fish food annually of which 200,000t are sandeels, 100,000t discards, 70,000t offal (Hunt and Furness, 1996). This compares with North Sea landings by the fishing industry in recent years of ca 2.5 million tonnes from an estimated average total biomass of ca 10 million tonnes (Svelle *et al.*, 1997). Thus, in terms of competition for a shared resource, fisheries probably have greater effects on seabirds than *vice versa*.

To clarify the major current research themes in managing and resolving conflicts between fisheries and seabird populations, it is convenient to divide impacts into, respectively, 'direct' and 'indirect' (Dunn, 1998). Direct impacts are those which inflict outright mortality on seabirds by entanglement in fishing nets and lines. Indirect impacts affect seabirds, positively or negatively, through changes in the food chain caused by fishing. In the second half of the twentieth century, emerging and growing indirect impacts include (1) the general depletion by fisheries of top fish predators (e.g. cod and mackerel), thus allowing their small fish prey (e.g. sprats, sandeels) to expand in numbers; (2) the subsequent targeting of these abundant small prey by industrial fishing; (3) the provision of fish waste in the form of discards and offal. Trends (1) and (3) are thought to have benefited seabird populations by enhancing their food supply, albeit (3) at the expense of favouring some of the more adaptable seabird species over others and thus significantly altering overall seabird community structure. Trend (2) represents a threat to seabird numbers with its potential to deplete prey resources of importance to breeding concentrations of seabirds.

Review of major current research themes

Current research themes are increasingly addressing the failure until recently to integrate the assessment and monitoring of seabird and fish populations. This dysfunction reflected the traditionally different priorities of seabird and fishery biologists, their institutional isolation, and inadequate integration of environmental concerns into fisheries management.

Seabird role in multispecies assessments

A research theme of ICES Working Groups in recent years has been to develop the information necessary for including seabird prey demands in multispecies assessments for fisheries management, i.e. for enabling the impact of seabirds on fish stocks to feature adequately in the models of natural mortality used by fishery managers, and conversely enabling management schemes to account for the needs of seabirds. To this end, a model has been developed for the North Sea which incorporates seasonal and spatial variation in seabird numbers, energy requirements, diet, energy contents of foods, and assimilation efficiency (Hunt and Furness, 1996).

Re-focusing the scale of study

A key conclusion from this modelling exercise has been recognition of the need to consider fisheries at a spatial scale relevant to the needs of seabirds (ICES, 1995). Put simply, localised changes in prey stocks are likely to be more relevant to breeding seabirds than, e.g. North Sea wide changes. This perception has major implications for the spatial scale of stock assessment, and indeed of fishing effort regulation, for fish species such as sandeels which are targeted by both fisheries and breeding seabirds. Peter Wright at Fisheries Research Services (FRS), Aberdeen, has studied stock discreteness in North Sea sandeels with respect to reproductive and geographical isolation. The aim was to provide a better spatial basis for monitoring sandeel fisheries and to examine the implications for other species which depend on sandeels as prey. In other words, it matters to seabirds whether the North Sea stock is one homogenous entity or a mosaic of discrete sub-stocks capable of local depletion by overfishing.

Development of research on seabirds at sea

The growing applied area of seabird ecology has increasingly cast off the shackles of land-locked studies on breeding biology which prevailed up till the 1970s. Since then there has been a major shift towards understanding the ecology of seabirds at sea; techniques for counting and mapping distributions offshore have been perfected and the miniaturisation and ready availability of devices for remote telemetry are facilitating insight into the fine-scale use that seabirds make of the marine environment, and their relationships with fish stocks and fisheries (Skov *et al.*, 1995; Tasker and Reid, 1997).

Potential effects of industrial fisheries on seabird populations

The dramatic collapse of the inshore Shetland sandeel stock in the 1980s, resulting in widespread breeding failure of sandeel dependent seabirds and closure of the fishery, initially brought fishers, fisheries managers, and bird conservationists (most notably the RSPB) into sharp conflict. This soon led, however, to an unprecedented level of cooperative research and dialogue on the interaction of seabirds and sandeel stocks, and on the best way to manage the fishery. The outcome has been to develop a management regime sensitive to the needs of both fishers and seabirds. This represented a pioneering application of the precautionary approach, and indeed of an ecosystem approach, to managing finfish stocks in European waters.

The results from this study have further prompted and informed a review of the threat sandeel fisheries pose to other 'sensitive areas' in the North Sea, notably the Wee Bankie sandeel grounds in the Outer Firth of Forth (east Scotland). Here there has been a 3-year (1997-99) multi-disciplinary study ('ELIFONTS': Effect of Large-scale Industrial Fisheries on Non-Target Species) into the dependence of local breeding seabirds and other marine wildlife on the Wee Bankie, and the potential effects of the Danish-led sandeel fishery on those predators. Co-funded by DG-XIV, ELIFONTS is a cooperative project involving the Danish Institute for Fisheries Research and the following UK bodies: Institute for Terrestrial Ecology, Newcastle University, Scottish Office Agriculture Environment and Fisheries Department (SOAEFD) and Sea

Mammal Research Unit. As such, the ELIFONTS has drawn on the combined skills of fisheries-, bird-, mammal-, and benthic biologists, and used state of the art technology, e.g. Roxan sonar for sediment mapping, and VHF and satellite telemetry for studying the foraging ranges and patterns of the predators.

Bycatch studies

The level of uncertainty inherent in determining the scale and effect of *indirect* impacts, such as sandeel fisheries and changes in discarding patterns, is obvious and poses a formidable challenge to formulating a management response. By comparison, in management terms, *direct* impacts (as defined above) of fisheries on seabirds are potentially more tractable. It is possible, for example, to evaluate the incidental mortality inflicted on seabird populations through ensnarement on the baited hooks deployed by demersal longlining in the North-east Atlantic, and to devise solutions based on improved gear selectivity.

The majority of longlining in waters around Britain is carried out by Norway and Spain, the latter mainly for hake in the Celtic Sea. Norway longline vessels mainly target ling, tusk and cod off north and west Scotland and up into the Norwegian and Barents Sea. Research by Norwegian fisheries scientists (Løkkeborg, 1996; Bjordal and Løkkeborg, 1996) and by the RSPB in alliance with its Norwegian BirdLife International partner (Norsk Ornitologisk Forening) (Dunn, 1997; 1998) is elucidating the scale of mortality on fulmars *Fulmarus glacialis* and testing the relative efficacy of different mitigating measures. Although the status of fulmars is not threatened by longlining (the species has expanded more than any this century, in numbers and geographical range, apparently prospering on the offal discharged by the fishing industry), longline vessels collectively take a significant toll of fulmars and have an obligation to minimise bycatch of this and other non-target species.

In multi-disciplinary terms, the resolution of seabird bycatch in longlining is of particular interest to the fishing industry. Apart from unwanted seabird mortality, this interaction incurs financial losses for the fishers, both in terms of bait loss and reduced fish catches (every baited hook taken by a seabird is a hook denied to a fish). Bait loss to fulmars of up 70% has been reported under certain conditions in the Norwegian Sea (Bjordal and Løkkeborg, 1996). The argument for plugging this economic hole gives extra leverage in the push for technical solutions to eliminate seabird bait snatching and bycatch, creating a potential win-win where the interests of fishers and seabird conservation are simultaneously met.

The most effective deterrent to seabird bycatch will probably be not one but a suite of measures embracing a line slackening device (to make the line sink faster on initial deployment), weighted lines, a streamer line to scare away birds, and changes in onboard procedures to eliminate discharge of offal during line setting.

Major themes for future research

With special reference to the North-east Atlantic, the relationship between current and future themes can usefully be examined in the light of:

* the *Statement of Conclusions* from the Intermediate Ministerial Meeting on the Integration of Fisheries and Environmental Issues.

* new Annex V to OSPAR Convention on the Protection and Conservation of the Ecosystems and Biological Diversity of the Maritime Area (major implications for the OSPAR Action Plan 1998-2003).

The success of the North Sea Conferences has effectively woken up and revitalised the sleeping giant of OSPAR, and the new Annex V agreed by ministers at Sintra in 1998 is an undoubted catalyst to multi-disciplinary research. Already it has generated preparation of a Quality Status Report for the entire OSPAR maritime area. Together, the IMM and OSPAR now give impetus to the development of research, with implications for seabirds, on the following issues[1].

* application of a precautionary approach to management of living marine resources;

* commissioning the work necessary to develop an ecosystem approach;

* elucidating the effects of different fisheries on ecosystems, giving priority to the effects of beam trawling and industrial fisheries;

* restricting fishing in areas where gears or practices are judged to have a disproportionately harmful impact on species and habitats (i.e. 'sensitive' areas); applying measures, particularly better gear selectivity, to reduce bycatch of non-target organisms (seabirds, mammals, benthic organisms);

* environmental assessments of new fishing activities, with the aim of minimising adverse effects on the marine ecosystem;

* steps to protect or restore biological diversity and habitats, including the establishment of temporarily or permanently closed or protected areas (OSPAR is committed to establishing a network of Marine Protected Areas);

* investigating socio-economic effects of alternative options for regulatory regimes for the conservation of fish stocks and/or the protection of the ecosystems; and

* investigate ecological and economic effects and practicability of applying a discard ban.

In translating these strategies into action on particular interactions, the following will likely be important future themes (and here I do not confine myself entirely to seabirds):

[1] The following bullet points are an edited version of comments made at the IMM in Bergen.

Possible impacts of industrial fishery for sandeels on seabirds and other marine wildlife

Key research requirements are identification of sensitive areas for potential designation, requiring work similar to that described for ELIFONTS above, effects on seabird performance of local area closure to fishing (one or more trial closures should be established and the effects monitored), and investigation of other possible management measures (regional catch limits, effort control).

Potential ecological effects of applying a discard ban

Some insight into the potential effects of a total ban may be gained from looking at the impact of the fleet capacity reduction targets of 20-30% agreed in the EU's Fourth Multi-annual Guidance Programme (MAGP IV), which, along with improved technical conservation measures, should cause a significant downturn in fishing mortality in Community waters, and thus in the generation of discards and offal. This in turn is likely to impact on populations and behaviour of certain seabirds. While unlikely to have implications for the management of fisheries *per se*, a potentially major ecosystem shift of this sort demands an assessment of the possible impacts, for which experience from the closure of the Grand Banks cod fishery is available to inform likely responses and trends. The RSPB is already studying the Scottish fisheries in this respect. The EC has initiated a project to develop and test onboard discard sampling programmes. This has a relatively short lifespan but if extended it could establish the baseline necessary to track changes in the volume of fish waste.

Impact of longline fisheries on seabird populations

In Rome, February 1999, the FAO-COFI formally adopted an International Plan of Action (IPOA-SEABIRDS) for reducing incidental catch of seabirds in longline fisheries. Although voluntary, it will require signatory states to assess if they have a seabird bycatch problem, and if so to develop a National Plan of Action (NPOA-SEABIRDS). Implementation of NPOAs (to start no later than 2001) will require complying States to design, implement and monitor a national plan, involving development of technologies to reduce seabird bycatch. This programme demands widespread collaboration with FAO and other institutional arrangements for research, training and awareness raising. Assessment and monitoring call for independent observers aboard vessels, experienced in identifying seabirds and estimating their densities.

Other marine wildlife issues

While this presentation focuses mainly on seabirds, the following specific issues should also command priority attention from marine research in the next five years:

* *Bycatch of small cetaceans* in bottom set gill nets (Iceland, Norway, North Sea and Channel) and pelagic trawls (North Sea, Celtic Shelf, Bay of Biscay). Independent observer monitoring schemes needed to determine scale of bycatch and to inform reduction targets.

* *MPAs*: Development of criteria and identification of potential sites for offshore Marine Protected Areas (MPAs) in the OSPAR Convention Area. Some seaduck may be candidates for such protection. However, protection of fragile benthic communities (e.g. *Lophelia* reefs off the mid-Norwegian coast) from trawling damage is a priority for application of the MPA tool. MPAs should conserve not just the most threatened species and habitats but also areas representative of high biodiversity and, in some cases, areas in need of restoration.

* *No Take Zones*: These are an extreme form of MPA management where fishing is excluded rather than allowed controlled access. Apart from protecting commercial fish stocks, NTZs could also be used to protect species of conservation concern, such as skates and rays. Conservation of the latter is boosted by the recent adoption of the FAO International Plan of Action for the Conservation and Management of Sharks (IPOA-SHARKS) which, like IPOA-SEABIRDS (see above) has to be translated into National Plans of Action by 2001.

* *Deep water fish*: There is an urgent need for basic life history details and better assessment of the target species of continental slope fisheries in the North Atlantic. For example, ageing techniques have been validated for only three of the 340 deep living teleost fish species and for only one of the 40 shark species. The effects of deep water trawling on benthic communities is also a key concern, arguably meeting the IMM requirement for environmental assessment of new fishing activities.

Gaps in knowledge of fisheries and their management across the discipline spectrum

Here I take an overview of some key gaps, several of which are already specified or hinted at in the various issues flagged up in earlier sections.

The major steer being given to the application of the *precautionary approach* on the one hand, and the development of an *ecosystem approach* on the other, raises major issues for the integration of environmental objectives (for seabirds or any other biota) into fisheries management, issues which need to be addressed by a multi-disciplinary approach. The Ecosystem Approach is still at the stage of needing to be more closely defined, while the Precautionary Approach needs to be elaborated and implemented.

Both of these exercises call for *better assessment of impacts and risks*. A major challenge is to define appropriate levels of fishing mortality for non-target species and acceptable levels of habitat disturbance. In the IMM's language, what do we mean by a 'disproportionately harmful impact'? The development of mitigation plans for longlining impacts on seabirds require us, for example, to assess the status of the North Atlantic fulmar population and the likely threat to that status from longlining. Species resilience is a relevant factor in this. The approach to defining limits is preferred here to any concept of ecosystem equilibrium which will be intractable to management.

Marine Protected Areas and *No Take Zones* are not to be regarded as long overlooked panaceas, rather as options in a suite of possible measures for protecting species and habitats. At present, the *evaluation of these tools in relation to other options* is a key task and one which is still in its infancy. Indeed, as recognition grows for 'environmentally friendly' fishing, the judicious application of not just these but other restrictions on fishing effort will need to addressed on a multi-disciplinary basis in pursuit of an overall management strategy, as acknowledged in the IMM commitment to investigate socio-economic effects of alternative regulatory regimes for conserving fish stocks and the ecosystem.

However, the designation of one element of MPAs, the EU *Natura 2000* network of sites for protecting representative European marine species and habitats, is already well advanced and the issue is now not so much 'if' and 'where', but 'how' to manage Natura 2000 sites. The process of achieving workable arrangements with the fishing industry in the management schemes for Special Areas of Conservation (SACs) under the Habitats Directive will be a key area of activity in the next few years. This highlights a more generic need to address the *spatial scale of fish stock assessment and regulation* in order to render fisheries management sensitive to localised ecosystem effects.

There is a growing requirement to *research and develop more selective gears to minimise incidental mortality* of seabirds and other marine wildlife (notably small cetaceans). R&D into mitigating measures for longlining is already a vibrant area for manufacturers but as yet there is minimal implementation. There is an associated need for field trials of new equipment, for assessing efficacy in relation to alternatives, and for advocating best (and most cost effective) solutions to the fishing industry, with the help of incentives as appropriate. In the case of bycatch of small cetaceans, their behavioural responses to different mitigating measures are little known, yet better understanding is a prerequisite for effective solutions.

How to fill these gaps by a multi-disciplinary approach

What are we trying to manage and how do we get there?

I agree with Symes (1998) that the complexity of the marine ecosystem defies rational management. As Niels Daan (1998) puts it: 'As long as the indirect effects cascading through the ecosystem remain largely unknown, there is no room for *ecosystem management*: the effect of potential management measures in relation to broad ecosystem objectives cannot be predicted quantitatively. The suggestion derived from the term ecosystem management to promote some utopic configuration is a false one, based upon an unrealistic belief in 'makeable' systems.' So we cannot sustain the ecosystem *per se*, rather we can only sustain the use of its resources. With these limitations, Daan concludes that the ecosystem approach to management is primarily an extensive monitoring programme that keeps a finger on the pulse of the ecosystem in relation to the various human impacts on its resources. The challenge then becomes one of agreeing what 'overexploitation' means, i.e. the limits to sustainable use.

This is an important perception as it serves as a health warning to over-zealous modelling. The greater trophic complexity we factor into our models, the more

delayed, the more conservative and less transparent is likely to be our advice to managers. In the end, the more pragmatic approach in many cases may simply be to agree on the characteristics and limits of overexploitation, accepting the prevailing uncertainty in the system, then regulate use of damaging gears and practices (in the case of a direct impact) or - in the case of an indirect impact - adjust fishing effort accordingly.

Again recognising these limitations, it is hard to disabuse Symes' (1998) view that the ecosystem approach to management is not a paradigm shift but an incremental approach, achievable through a more integrated approach to management. In practical terms, 'coordination' is a less ambiguous term that 'integration', a multi-disciplinary approach being best served by the pooling of expertise in pursuit of a mutually acceptable goal.

It is important that the consensus building begins as early as possible in the process. Only by giving environmental issues greater parity with those of commercial fisheries, and making them core to the dialogue, will we move away from adverse environmental effects of fisheries being regarded as peripheral 'problems', soluble only by a reactive, firefighting strategy which, by its nature, can be ineffective or even counter-productive.

Institutional coordination

The UK House of Lords Select Committee on Science of Technology enquiry (HMSO 1996) into 'Fish Stock Conservation and Management' recommended improved communication between scientists, fishermen, managers and politicians, and called on the UK Government to take the lead in sponsoring multi-disciplinary research into the effects of the environment on fisheries and *vice versa*. One specific proposal was to set up a multi-disciplinary institute in fishery science, serving either the UK or Europe as a whole. They also recommended the establishment of panels, ideally involving all stakeholders, aimed at reaching consensus on management advice for identified fisheries, to precede the relevant ICES/EU meetings. The enquiry also adduced that 'scientific professionalism is currently providing an excuse for political compromise.' This criticism was aimed at making ICES and the EU give advice in such a way that decision makers were left in no doubt which option accorded with the precautionary approach.

- *ICES*

  In its evidence to the House of Lords Select Committee enquiry ICES reported that it was considering expansion of its remit to include the assessment of 'fisheries management systems' but progress could only be made if and when an appropriate institutional framework was developed. At the 1995 Greenwich Forum meeting ('Fisheries in the Future: Sustainability or Extinction'), the late Roger Bailey of ICES echoed this, arguing that the days of giving purely biological advice were coming to an end, that economic advice was also needed, but that there was currently no forum for biologists and economists to get together to formulate such advice (reported in *Eurofish* 453, Apr 27, 1995, FS/1). This still remains a challenge.

In 1998, ICES incorporated a strong precautionary approach (developed in a designated Working Group) in its advice on catch limits for target species. The ICES recommendations, which were largely endorsed by the EC and the Council of Fisheries Ministers, represent a profound watershed in management of North-east Atlantic fisheries. However, ICES still faces the challenge of better incorporating into its advice the impacts of fisheries on non-target species and habitats. In her presentation to the ICES/SCOR (Scientific Committee on Oceanic Research) Symposium on Ecosystem Effects of Fishing (Montpellier, France, 15-19 March 1999), Kathy Richardson (former chair of ICES Advisory Committee on the Marine Environment: ACME) argued that management of sustainable fisheries cannot be achieved without accepting that the ultimate goals of fisheries and environmental management should be the same. To this end, she argued that ICES should have only one advisory committee, including both fisheries (currently ACFM) and environmental (currently ACME) components, and that the existing separation can only perpetuate the 'firefighting' approach to environmental impacts described above. However, she acknowledged that further synthesis is unlikely until the regulators shift their focus from just the target species and demand coherence in advice.

- *European Commission*

At the level of the EC, DGXIV's competency in fisheries management is well guarded, and has manifestly been a disincentive to coordination. With the exception of the Natura 2000 network, the footprint of the Environment Directorate-General (DGXI) on the Fisheries Directorate (DGXIV) is very light. Significantly, the two DGs have failed to produce - at least for public consumption - a joint strategy paper on fisheries management and nature conservation, first mooted in 1996 in the run up to the IMM. So the question remains: how to get DGXI more involved in addressing the fundamental marine conservation questions arising from fisheries as a separate issue from the sustainable management of commercial fish stocks?

It also needs to be remembered that, despite the North Sea Quality Status Report (QSR: North Sea Task Force 1993) identifying fisheries as a key impact on species and habitats, OSPAR cannot take measures on fisheries management but can only draw conflicts to the attention of the competent authority, DGXIV, in hope of resolution. This emphasises the heavy responsibility DGXIV bears to give due weight to the marine ecosystem in developing fisheries policy.

Horizontal strategies and coherence issues in EU policy challenge DGXIV to embrace this wider remit, most recently development and implementation of the European Community Biodiversity Strategy (ECBS). In this regard, it is notable that the EC's *Fifth Framework Programme* (1998-2002) does not include 'fisheries' as a sector identified for integration. If the assessment of the Fifth Framework Programme recommends a successor (sixth), then multi-disciplinary research in this area will be facilitated by adding fisheries to the five existing target sectors into which environmental concerns should be

integrated, and by formulating appropriate objectives for the fisheries sector. Attention to policy coherence is needed not least to create a germane climate for multi-disciplinary input into the forthcoming review of the Common Fisheries Policy (CFP).

The EC has certainly made significant progress in being more transparent and more accountable towards the various stakeholders in the CFP. However, a multi-disciplinary approach would be facilitated by fuller participation. The EC has formalised consultation with environmental and development NGOs in the last two years through formation of a Contact Group, and this has led recently to an active discussion with DGXIV on NGO representation in the Advisory Committee on Fisheries (ACF) and its Working Groups. However, this political dimension is still heavily dominated by the large-scale industry sector and, to reflect the balance and diversity of fisheries stakeholders, the Commission should also be more attentive to various groups whose interests are presently insufficiently addressed, notably fishing communities in the small-scale sector, including stakeholders affected by fisheries agreements with third countries.

The role of NGOs

Conflict resolution is a curve which begins with a steep and often fractious phase of 'problem identification' and 'awareness raising', the natural habitat of the NGO. Arguably, for at least some marine issues, this section of the curve has moved on and in these cases we are now turning the corner into the phase of 'solution finding' (although the synergy between the two phases is always required, not least because the curve is constantly reverting to phase 1 as it encounters resistance to action and failure to implement). It is this latter stage which, for example, has gained BirdLife International access as *bona fide* observers on board Norwegian longline vessels. In a pioneering arrangement, the evolution of conflict resolution also fostered co-management in the Netherlands in attempts to secure an equitable distribution of shellfish stocks between fishers and shorebirds.

This burgeoning consultative and co-management role poses a challenge to both NGOs and fisheries managers. The better resourced NGOs charged with protecting the marine environment are perceived as having the capacity for research and understanding of marine biodiversity. In pursuit of this, the RSPB has its own research department but also contracts out marine projects to a wide variety of sources, including statutory fisheries research laboratories, universities, policy institutes, etc.. This, in turn, places the NGOs' knowledge in high demand. In the developing climate of measured dialogue, transparency, and privatising sources of policy guidance, Governments and also IGOs (such as OSPAR) have a growing appetite for consultation with NGOs and this raises important questions for the NGOs about their own priorities, resourcing, capacity, prioritisation, advocacy skills and coordination. Also, as central bodies seek the consensus view of NGOs, the individual flavour of particular NGOs and their 'hybrid vigour' threatens to be diluted in the bottleneck process of building a broad church with narrow aisles, although this is an inevitable price of compromise in joining the consultation process. The developing engagement

between the NGOs and the EC's Advisory Committee on Fisheries (ACF) highlights just such issues.

The key challenge for the NGOs, therefore, is to play their co-management role without losing their edge as environmental pressure groups. To achieve this they have to strike an effective balance between campaigning and the demands of integrating into the management system. To continue to serve as grit in the oyster, the NGOs have - in the analogy of Bjørn Hersoug's presentation to this Workshop - to perfect the art of remaining 'partly pregnant' (see page 85).

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2.5 Discussion

Bonnie McCay (Rutgers University, USA). There is clearly an incremental shift towards ecosystem management which we also find in other natural resource management domains. Although still tentative, it looks like a paradigm shift, moving from utilitarian decision making to incorporate respect for nature, and from a commodity oriented mode of management to embrace questions of multiple use, biodiversity and non-resources. There is also a tentative shift from top:down centralised management systems to decentralised - side-by-side or bottom:up - programmes of management. Within the policy community, resource users are being joined by many other groups and they in turn are shifting from consultative and lobbying roles to being more involved in management. These shifts are interactive. Science is framed by management enterprise but there are also shifts in management enterprise which affect science. Hitherto, the dominant situation has been top:down and reliant on scientific expertise generated in government institutions. If there is institutional change - as indicated above - will the location of expertise be redistributed? And given the concern for more complexity, does science have to become humbler and to incorporate other forms of expertise (e.g. resource users)?

Recognition of the limits to a single species approach to management implies a need for a more sophisticated analysis and a greater diversity of management tools (No Take Zones, MPAs, closed areas etc.). But how effective will this institutional change be? We also need to consider the impacts of a switch from reactive management to strategic management. In the US we now have 'strategic management' imposed by the environmentalist community through the law courts: it is now, for example, a legal requirement that overfished species must be rebuilt within ten years - a decision which places additional stress on the management system and gives scientists an impossible task. Finally, how do we value ecosystems? Here we may fall into the numerical trap: not everything can be reduced to a cost-benefit analysis or to monetary value. There are some categorical decisions to be made about what is right and what is wrong: that is part of the political reality.

Dirk Langstraat (Dutch Fisheries Board, Netherlands). Too much emphasis has been placed on the traditional science-led management framework. Scientists need to consider how to translate their research findings into language accessible to the public and they have to learn to make clear cut policy recommendations. The cost of additional research, outlined in some of the papers and advocated elsewhere, is likely to prove prohibitive for the both industry and for management. How much more detailed research do we really need? Can we achieve more by other means? Although there is a need for a holistic approach, involving a wide range of disciplines, there is also a need to shift from micro-level to meta- and macro-level frameworks in order to accommodate the cost benefit and limited knowledge and understanding of the policy makers. At present the worlds of researchers and managers seem too far apart.

There seems to be an untested assumption that the fishing industry is directly responsible for the ecological health of the seas. Fishing, as a minor sector of the national economy, is a soft target. We need to identify all those responsible for the ecological well being of the oceans and to find the optimal balance between economy and nature. At present that balance seems to be in danger of tipping towards the

welfare of marine wildlife. What we are looking for is the welfare of all living creatures. We need a paradigm shift that considers the impacts on human and wildlife populations equally and which can cost the proposals for wildlife conservation in terms of the fishing communities.

Nancy Shackell (Ecology Action Centre, Halifax, Nova Scotia). The present management paradigm puts too much emphasis on the quantitative approach and numerical models. Although we may talk of a new approach, the entire system is still oriented to quota management. We need to understand why the current numerical approaches are so poor and to refine our models in relation to risk. Other questions of importance are how to define 'sensitive areas' and to determine what scale of change to the ecosystem can be tolerated.

Open discussion raised the following points:

(i) The apparent exclusion from the Fifth Framework Programme of fisheries as a specific topic but the development of a multi-disciplinary definition of themes relating to the environmental and socio-economic aspects of marine ecosystem use. Are we losing sight of fisheries as a distinctive economic activity?

(ii) Throwing problems at science may be an evasion of responsibility and a way of avoiding risky decisions. Quantitative scientific analyses may not be able to provide a sufficient basis for decision making. For example, in getting the balance right over environmental conservation and economic exploitation, choices have to be made but not necessarily on the basis of scientific assessments. Qualitative or categorical decisions have to be made. We need to distinguish between what is a scientific issue and what is a political decision.

(iii) The presentations and discussions reveal a shared awareness of the limits of our scientific paradigms, the limits of scientific research in terms of costs and control factors and the limits of the institutional frameworks for management and scientific research. How then can we move forward within these constraints? Multi-disciplinary discourse on the results of existing research may be part of the answer.

3.0 ECONOMIC ISSUES

3.1 Economics and multi-disciplinary research in fisheries management

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Introduction

This paper aims at giving an economist's opinion on the role of economics in the study of fisheries management, and on the possibility of improving our understanding of the subject by developing cooperation between economists and non-economists.

Let me say first that probably *not* all economists would agree with the opinions presented in this paper. The possible disagreements lie not only in the field of economics as applied to fisheries, but more deeply in the field of economics in general. Notwithstanding the intensive use of mathematical instruments which makes some parts of the discipline look like theoretical physics, economics is a social science and shares with other social sciences some characteristics which make specialists of so-called 'hard' sciences look suspiciously at the methods and results of our so-called 'soft' sciences: loose experimentation of theories, interlacing of factual and value judgements. In a 1996 paper titled 'Why economists don't make discoveries', Edmond Malinvaud, an economist renowned for his contributions to econometrics and macroeconomic theory, wrote that 'the difficult conditions hampering scientific progress in economics also explain why several paradigms may coexist for a long time in our discipline, and why changes in the preferences of economists between different paradigms are more frequently due to changing fashions in the academic community than to evidence of their appropriateness as regards economic phenomena and problems of the real world'. And he added that 'if you agree with me on that statement, then, as scientists, we have no reasons for being proud of this situation. We, the economists, might then look more interesting as a theme of investigation for the sociology of science than as actors contributing to the progress of scientific knowledge' (Malinvaud, 1996).

The fact that similar problems are probably met by other social scientists is of little help. I shall however try to present, first, what is commonly considered as the mainstream of research in fisheries economics. Though focused on economics, this first part of my presentation will be open to some kind of multi-disciplinary consideration, since the mainstream of research in fisheries economics has a direct link with biology through what is called bio-economic modelling. The second part of my paper presents some recent orientations of economic research in fisheries management, from which one may reasonably infer some important themes for future research in the next few years. It will be seen, I hope, that these themes clearly call for a development of multi-disciplinary research, not only with biology but also with other social sciences. The third part of my paper is entirely devoted to discussing the question of multi-disciplinary research. The point is not so much the need for this type

of research in the field of fisheries management, which is now broadly acknowledged, as the question of impediments and of means to overcome them.

The mainstream of research in fisheries economics

Economic research concerning the fishing industry may focus on different types of topics: management of fish stocks and fishing activities, market problems, contribution of the industry to the balance of external trade, structure of the firms, spillover effects of fishing activities on employment in coastal zones ... However, economists studying the fishing industry are mainly concerned with the management of natural resources exploited by fishermen: at the last IIFET biennial conference in Tromsø (July 1998), there were more than double the number of papers dealing with that topic as papers dealing with fish trade problems (Eide and Vassdal, 1998). In order to explain this state of affairs, one has to recall that fisheries economics is a joint product of public economics and natural renewable resources economics.

The involvement of public economics in the study of the fishing industry is mainly due to the fact that most of the fish stocks exploited by fishermen may be described as common use resources (Copes, 1998). These resources are characterised by both properties of subtractability and non-excludability (Berkes *et al.*, 1989), and therefore are difficult to classify according to the standard distinction between private goods and public goods (Samuelson, 1954): like Samuelson's private goods, common use resources are subtractable, i.e. the use of such a resource by one individual decreases the total quantity available for others, and consequently their welfare as soon as the resource has become scarce. A resource is scarce if its marginal utility is positive at equilibrium: the availability of one more unit of the resource, *ceteris paribus*, could benefit at least to someone. Economics is concerned only with scarce resources or goods. At the same time, like Samuelson's public goods, common use resources are non-excludable, which means that it is very difficult (i.e. highly costly if not technically impossible) to allocate them *ex ante* between individual users, for example, by creating individual ownership rights as was done in agriculture with enclosures.

These two properties that characterise common use resources do not necessarily lead to a situation of the 'tragedy of the commons' (Hardin, 1968). Berkes *et al.* (1989) show examples of various institutional arrangements in traditional communities that allow for sustainability in the use of this type of resources. However, in the context of modern market economies there are good reasons, both empirical and theoretical, to believe that the combination of subtractability and non-excludability characterising fish stocks is a source of increasing problems in the fields of efficiency (overcapitalisation and overfishing) as well as equity (fisheries conflicts). The basic reason is that this combination generates mutual externalities between fishermen where the volume of catches realised by one fisherman partly depends on the fishing effort of other fishermen exploiting the same stock or other interacting stocks, resulting in a gap between private and social benefits of fishing. The private marginal productivity of fishing effort is usually higher than the social one (i.e. the impact of the increase of one unit of effort on the overall output of the fishery), because part of the surplus catches which one fisherman gets from increasing his effort is balanced by a decrease in catches of other fishermen, *ceteris paribus*. If fishermen rely on

individual costs and earnings to determine the level of their fishing effort (which is a reasonable behaviour for a player as long as the rules of the game are purely individualistic), the result is excess effort at the level of the fishery, which generally means overcapitalisation: higher incomes might be generated by the fishery if the global fishing power was reduced. The negative consequences of this 'market failure' become more obvious as resources become scarcer, since the discrepancy between private and social benefits of fishing is itself in direct relation with the scarcity of the resources. Overcoming them necessitates some kind of collective regulation, which is the basis of fisheries management, and the reason why fisheries economics may be regarded as a specialised division of public economics.

The living, and thus renewable, character of fish stocks complicates and often increases the problems related to their common use character. Not only is overcapitalisation a sign of inefficiency in the short run (too much capital invested in the exploitation of a given stock), but it may also generate long-run inefficiency by causing excessive mortality on the spawning stock (recruitment overfishing) or excessive catches of undersized fish (growth overfishing). Overfishing is sometimes misunderstood, because it is regarded as an antonym for biologically sustainable fishing. It is true that, under some circumstances, excessive pressure on a stock may cause its collapse, but in other circumstances overfishing is quite compatible with biological sustainability: the stock may be stabilised at a level which is simply inefficiently low. Overfishing may thus be a threat to the economic sustainability of fishermen (or at least to their welfare) before it is a threat to biological sustainability of fish stocks.

A good part of the economic analysis of fisheries management depends on bio-economic modelling, which is regarded by many fisheries economists as the hard core of their discipline. Basically, bio-economics deals with the productive activity in industries exploiting living resources. Describing the productive process over time in such activities implies accounting for the biological characteristics of the renewal of the resources exploited. Thus bio-economics combines technical and economic relations (production functions, demand functions, relations describing the economic behaviour of producers ...) with biological relations characterising the dynamics of the living resources exploited. Modelling is merely the transcription into a formal language (usually algebraic) of the relations which are assumed to describe the phenomena under survey. In the field of fisheries economics, bio-economic models usually combine a biological component (set of equations) describing the dynamics of the fish stocks subject to fishing mortality, a technical component describing the relation between anthropic inputs and fishing mortality, and an economic component describing costs and earnings of fishing and fishermen's behaviour.

The popularity of bio-economic modelling among fisheries economists may be attributed to various reasons, some of which are linked to the field of activity under survey, while others are of more general character. The main reasons seem to be the following:

* Fisheries management was studied by biologists before it became a subject of interest among economists. When economists started investigating the subject in the 1950s, they found in the biological literature a set of population

dynamics relations which provided a seemingly well established basis for developing their own economic models.

* Undoubtedly, some of these models have proved useful in helping to understand the interaction between biological processes and economic forces leading to situations of overfishing and overcapitalisation in the fishing industry, which have become more and more current in the recent decades. On this basis, the use of bio-economic models is often regarded by fisheries economists as a major key to sound fisheries management.

* In fisheries economics, as in other fields of economics, modelling has been considered over the last half century as a sign of maturity in the discipline. Notwithstanding the relatively poor performance of many economic models as regards predictive capacity, the fascination for 'hard' science has sometimes led economists to consider the intensive use of mathematics as a proof of the scientific character of their research activity (Leontief's 1970 comments on this subject still apply).

Recent developments and new trends

In an applied discipline such as fisheries economics, the evolution of research themes is dependant on three different factors: so-called 'social demand', analytical instruments and available empirical data. These factors are not fully independent: for instance, the decision to allocate scarce resources to the collecting of a certain type of data often depends on the social concern with the information allegedly provided by these data. However, progress in data collecting does not always go at the same pace as progress in analytical tools (theoretical models, econometric methods), and both are not always in tune with the evolution of social demand. For this reason, a 'good question' does not necessarily make a good research programme. Compliance with the rules set up by authorities in charge of fisheries management is certainly a question of high importance in practice, and is also an interesting subject from a theoretical point of view. (Economic theory displays a growing interest in this type of subject, and more generally in questions related to informational asymmetries, in particular with the development of so-called 'principal agent' models). It remains to be seen whether empirical research in this field may be fruitful, due to the lack of data and the obvious reluctance of persons concerned to give reliable information on this sensitive subject.

Identifying what will be the major themes for future research in fisheries economics over the next five to ten years looks like a risky challenge, all the more so since economists are well known for their ability to forecast mainly past events. Fortunately, under normal conditions the evolution of research programs is smooth enough to allow getting some useful information through observing recent developments in research activity, specially in a discipline like economics, where researchers 'do not make discoveries' (Malinvaud, 1996). In addition, as research in fisheries economics mainly relies on public funding, looking at public research framework programmes (e.g. European Commission, 1999) gives reasonably reliable information on what will be the major themes of investigation for the period covered by these programmes, simply because they tell us what sort of research will be financed. However, the following list does not pretend to be exhaustive.

Unsurprisingly, recent developments in fisheries economics show a tendency to growing sophistication in bio-economic modelling. The shift to more sophisticated models is intended to give a better representation of the complexity of fishing activities and their interaction with marine ecosystems (stochastic models, multispecies models, models integrating discards ...), and / or of the objectives of fisheries management (multi-objective programming). At the same time, efforts are made to improve the quality and diversity of empirical data which are to be used as inputs in the models (measuring discards and not simply landings, development of fieldwork in order to evaluate costs, revenues and characterise fishing strategies ...).

Fisheries economists - some of them at least - also seem increasingly interested in having a closer look at what is happening inside the black-box, by investigating the mechanisms of fisheries management. In this field, interest has up to now mainly focused on the pros and cons of different management tools (quotas, licences and so on), and on the highly sensitive question of the transferability of individual fishing rights. Growing concern is manifested for such questions as the institutions in charge of fisheries management (participation of fishermen to management, level of management ...), the actual ends they seek (so-called 'biological, economic and social' objectives), their mutual compatibility, the consistency between objectives and methods of fisheries management, the cost of enforcement of regulations and their distributive effects. Welfare economics is supposed to answer two types of basic questions: 1) what changes are liable to improve global surplus? and 2) who will profit, and possibly who will suffer from these changes? Feeling more comfortable with considerations of efficiency than with considerations of equity, economists sometimes privilege the first type of question and display benign neglect for the second one. Even on the ground of efficiency, this attitude may be short sighted because globally efficient adjustments may be hindered by the opposition of social groups who feel, rightly or wrongly, that they will not profit from these changes.

Another noticeable tendency is the growing interest for studies integrating fisheries management problems into a broader framework, including for instance the conservation of marine ecosystems or coastal zone management. This tendency implies a shift from the traditional prey-predator model to a representation privileging environmental and social interactions between the fishing industry and other (competing or complementary) activities (upstream and downstream activities, environment conservation, tourism, aquaculture ...). It means, for instance, that economic valuation of fish does not rely only on their commercial value, but that economists have to consider (and measure) the existence value of both commercial and non-commercial species and, more generally, of ecosystems. 'Green labelling' might become an important subject of investigation in the next few years. The translation of the 'precautionary principle' into operational terms is also a subject of interest.

Multi-disciplinary research

From its very beginning, fisheries economics has been allegedly strongly acquainted with multi-disciplinary research. Bio-economic modelling is supposed to be a joint product of biologists (who provide the relations describing the dynamics of fish stocks) and economists (who provide the relations describing costs, earnings and

fishermen behaviour). The relation between anthropic inputs and fishing mortality, called the production function by economists, is at the junction between biology and economics. It is also a subject of long lived misunderstandings between specialists of the two disciplines (for a review from the economic side, see Rodgers, 1995).

Fascination for natural sciences is high among economists, all the more so when these sciences make an important use of mathematical tools (which is clearly the case for population dynamics in biology). But economics is a social science, and economists are not the only social scientists involved in the study of fisheries management. One could therefore expect that a cooperation between economists and other social scientists interested in the subject to be fruitful, and the development of such cooperation is strongly advocated by some major specialists in fisheries economics (Copes, 1998).

Recent trends of research, as well as public research framework programmes also seem to push in that direction. For instance, studying the 'black-box' of fisheries management or the reactions of fishermen to regulations intuitively calls for a multi-disciplinary research involving political scientists, legal experts, sociologists, economists (the list is not limiting). This does not mean that fisheries economists are faced with the alternative of working either with other social scientists or with biologists - they can indeed work with both (see, for example, Boncoeur *et al.*, 1998). The true alternative is between working in isolation or working with other researchers, be they biologists or social scientists, involved in the same field of interest. My personal feeling is that fisheries economists, as well as other scientists working on the subject of fisheries management, can greatly benefit from working in association, because for a good many questions which they try to solve, each one holds a piece of the puzzle. For instance, the determinants of the behaviour of fishermen, the implication of various social groups in the institutions in charge of fisheries management are subjects of great interest for economists, and for which other social scientists certainly have much to provide.

However, asserting the potential benefits of multi-disciplinary research is one thing, and actually doing the job is another thing. The impediments are well known, with a list ranging from semantic problems to the lack of incentives for researchers to engage in multi-disciplinary research. I would just like to stress here the problem of occasional misrepresentations of other disciplines by specialists of one discipline which, if not properly treated, is a serious threat against attempts to develop multi-disciplinary research.

An example of this phenomenon is provided by the allegedly 'biological' sub-stratum of some bio-economic models used by fisheries economists. The famous Schaefer model (1957) is the historical basis of bio-economics and, is still today, a useful pedagogical device, helping people to understand what is recruitment overfishing and what are its economic consequences. However, the Schaefer model and its derivatives use a type of representation of population dynamics which, according to biologists, is in most cases highly unrealistic as regards fish stocks. There are two reasons for this: 1) these models are 'global' - they neglect the class age structure of the stock, a characteristic frequently of major importance for stock assessment as well as fisheries management (see, for instance, Mesnil, 1989); and 2) they are 'self regenerating' -

they rely implicitly on a stock-recruitment relation, the existence of which is contradicted by empirical evidence concerning most species exploited by fishermen (see, for instance, Lasker, 1989). For these reasons, the Schaefer model and its derivatives can hardly be regarded as a sound basis for bio-economic modelling applied to fisheries of the real world - a situation which some economists do not seem to be aware of, maybe because of the fascination exerted by the possibility of applying to such models the elegant mathematical tools of dynamic optimisation, and probably because of lack of interest for what is happening in the real world. Notwithstanding that, this class of models, once coupled with the mathematical theory of optimal processes, has given rise, over the last 25 years, to an impressive and brilliant bio-economic literature liable to leave the layman with the impression that the time path of a fishery can, and should, be controlled like that of a rocket.

As a result, the 'biological' component of an important class of bio-economic models developed by economists has little to do with biological models actually used by fisheries biologists, who rely much more on Beverton and Holt's methodology than on Schaefer's. This is an interesting case of spurious multi-disciplinarity and probably one of the reasons why so little use is made of bio-economic models in actual fisheries management. The consequences are not too bad as long as models built by economists do not pretend to be anything other than intellectual games aimed at demonstrating their ability to use mathematical tools (except for the fact that it probably strengthens the natural suspiciousness of the external world towards the profession of economists), but they can be more harmful if one intends to draw from the models some practical conclusions concerning the management of actual fisheries, as is sometimes the case. Of course, it is fair to stress that bio-economic modelling is not limited to this caricature: economists interested in bio-economic modelling make use of various biological components, and considerable effort has been made by some of them to increase the realism of relations assumed in the models, both on the biological and economic sides (for a presentation of the main types of bio-economic models in use, see Hannesson, 1993).

Economists, however, are not the only group of scientists subject to the shortcomings of misrepresenting the (actual or potential) contribution of other disciplines to a subject of common interest. Indeed, they are sometimes themselves the victims of this phenomenon. An example may be found in the way non-economists often consider the economic part of the so-called 'biological, economic and social objectives' usually assigned to fisheries management.

Economics is often assimilated to money matters and private money incomes. Therefore the allegedly 'economic objectives' of fisheries management are often interpreted as meaning merely the maximising of private profits generated by the fishery, and one frequently hears that social and / or ecological considerations are at odds with economic considerations in fisheries management (and in many other places as well)[2]. But this is not necessarily so. Though money matters and private money

[2] For a suggestive presentation of the three paradigms involved in fisheries management and fisheries conflicts, see Charles (1992). Boncoeur and Mesnil (1997) have proposed a confrontation of Charles's 'triangle of paradigms' to the case of the European CFP. In this paper they criticise the opinion according to which, in fisheries management (and more specifically in the case of the CFP), social objectives are given up for the achievement of biological and economic objectives.

incomes undoubtedly play an important role in many economic arguments, economics is not specifically about these topics. Economics is about the allocation of scarce resources between alternative uses. Obviously, the scope of this classical definition is broader than the market sphere: for various reasons, the scarce resources to be considered are not necessarily saleable, and the uses of these resources may be collective as well as private. The key question of economics is that of choice, be it private or public, under conditions of scarcity, and this question involves considerations of efficiency and equity.

According to the Pareto criterion, an allocation of scarce resources inside a system is efficient if it is not possible, by reallocating some of these resources, to improve the satisfaction of one individual member of the system without diminishing the satisfaction of any other individual member. It is true that, *under some conditions*, there is a relation of equivalence between an efficient (or so-called 'Pareto-optimal') state of the system and a situation of competitive market general equilibrium. But this central theorem of welfare economics certainly does not mean that 'the best of the worlds' should be expected as the mere result of free competition and private profit seeking. First, the conditions of equivalence between market equilibrium and Pareto optimum are so restrictive (perfect competition, no externalities, no public goods) that, according to Joseph Schumpeter (an author whose commitment to the cause of economic liberalism can hardly be suspected), any attempt to justify economic liberalism on the grounds of such a theorem is not only vain but counterproductive (Schumpeter, 1943). Second, the criterion of efficiency is (analytically) free from equity considerations: a Pareto-optimal state of the economy may well be regarded as a pretty unfair situation by a vast majority of the population. Contrasting with the criterion of efficiency, economists have no professional qualification for defining a criterion of equity, which is essentially ethic or political: their opinion on the subject is not more qualified than that of any other citizen. But it certainly does not follow from this that economists should ignore equity considerations, and are authorised to assimilate welfare and efficiency: the welfare of a community, whatever the exact definition given to this expression, obviously depends both on efficiency and equity. To sum up: efficiency is not equivalent to profit maximisation, and welfare is not equivalent to efficiency.

As regards fisheries management, this means that the scope of interest of economists, beyond the global amount of profits earned by firms operating the fishery, extends to such matters as the distribution of these profits (and, more generally, various money and non-money incomes generated by fishing activities), employment, the existence value of non commercial species and ecosystems, and many other topics not necessarily labelled as 'economic' by the layman. Economists cannot feel comfortable with presentations of fisheries management problems opposing 'economic rationality' to 'community welfare' or 'ecological sustainability', and multi-disciplinary research including economists simply cannot work if some of the participants stick to this type of presentation (this question is discussed in further detail in Boncoeur and Mesnil, 1997).

A number of conditions are attached to the notion of inter-disciplinary research in fisheries management. I will mention only two. One condition is that representatives of each discipline in an inter-disciplinary programme have a clear representation of

what the other disciplines are about. Of course this does not mean that they have to be 'specialists' of the other disciplines: the worst case, maybe, is when specialists of a discipline A pretend to know better than specialists of a discipline B what the latter is about, but it would be fine if they had a basic but correct idea of the scope and methods of other participating discipline(s). This is all the more important since all those involved will have to talk together about the same topics, but from different standpoints. Cooperation between biologists and economists, for instance, is made easier once economists have fully realised that, for biologists, fishing is a cause of mortality of fish among others, and once biologists recognise that, for economists, fishing is a productive activity among others. This assertion may look trivial, and certainly it is; nevertheless, a good part of the misunderstandings about fishing effort, or about 'MSY v MEY' is rooted precisely here. A reasonable degree of knowledge of what the other participants are concerned with is also a good way of knowing what help they could provide in your own work, and what are your own limits: economists, for instance, should leave population dynamics to biologists, while in the same time biologists should refrain from defining so-called 'biological optima', an expression which is by itself pure nonsense. The maximum sustainable yield (MSY), sometimes presented as a 'biologically optimal' state of the fishery, is in fact a very special case of (economic) optimum corresponding to the highly improbable case where the marginal cost of fishing effort is zero. Biologists, it is true, nowadays seldom refer to the MSY as a criterion for fisheries management.

Another important condition of success for a inter-disciplinary research programme is that the question to be answered be defined precisely, and in terms accepted by all participants. Division of labour requires that each contributor knows what is his expected contribution to the common product, and this cannot be done if the product is not clearly identified. Of course this requirement is not specific to multi-disciplinary research, but it becomes more crucial here, because the 'common knowledge' is usually much weaker than in inter-disciplinary research, and therefore the risk of misunderstandings higher.

Let me illustrate this remark with the experience of a recent inter-disciplinary research program devoted to the analysis of fisheries conflicts and fisheries management in the Normand-Breton Gulf (ICES VIIe)[3]. The subject to be investigated was the high occurrence and variety of fisheries conflicts in this area, and the poor results of efforts to solve them by allocating space between different groups of users. It was decided by the participants to organise the research so as to test a hypothesis concerning the conflicts. According to this hypothesis, the various and interacting conflicts observed in the Normand-Breton Gulf are exacerbated by a common factor, which is global and growing overcapacity in the fisheries of the area. The overcapacity hypothesis was not chosen by chance: first, economic analysis of fisheries suggests overcapacity is plausible, except if efficient regulations are adopted to curb the phenomenon; second, the overcapacity hypothesis seemed to provide a good explanation for the unfitness of territorial arrangements as regards a durable settlement of the fisheries conflicts. Once an agreement on the question to be answered was reached by participants to the

[3] This programme, funded by the French Ministry of Agriculture and Fisheries, involved biologists from IFREMER, and jurists and economists from the University of Western Brittany (CEDEM). Its problematics and first results were presented in April 1998 at the Xth conference of the EAFE which was held in The Hague (Boncoeur *et al.*, 1998).

programme (is the overcapacity hypothesis supported by facts?), the job was divided between them. The role of jurists consisted in analysing the quite intricate set of regulations applying to fishing activities in the area, and sorting out the regulations which were liable to limit the accumulation of fishing capacity. The role of economists and biologists consisted in examining empirical evidence of overcapacity. The investigations conducted by specialists from the different disciplines were confronted several times during the research, which helped each participant to direct their own investigations. The main conclusion of the research was that the hypothesis tested was reasonably supported by facts: weakness of the institutional mechanism regulating the fishing capacity in the Normand-Breton Gulf, evidence of an economic stimulus to increase fishing capacity, comparative evolution of fishing capacity and landings, increasing misexploitation of the resources. The promoters of the programme now intend to develop it according to two hopefully complementary directions: modelling the interactions between fleets operating the Normand-Breton fisheries, and widening the programme to include other social sciences. For practical reasons, only jurists and economists were involved in the first stage of the programme, but the need for other social scientists expertise, which was already felt at the beginning of the programme, has become still more obvious in the course of its realisation. This remark applies notably to the understanding of the actual mechanisms of regulation of the fisheries (self-management appears to be much more important than a superficial look at official regulation mechanisms may initially suggest), and of fishermen's behaviour (response to economic incentives, reactions to regulations).

Conclusion

The above related experience is certainly not an example of what should be done. Just as, according to Engels, the proof of the pudding is in the eating, it is only presented here as an illustration of the fact that research in fisheries management involving biologists, economists and other social scientists is quite possible, and may even be fruitful, however modest may be the results obtained so far. This of course does not mean that the recipe for the pudding could not be improved.

The needs for multi-disciplinary research in fisheries management are many, and social demand for this type of research is increasing, as shows the European Commission's *Fifth Framework Programme*. It is up to specialists in various disciplines to display their willingness and ability to work together. I have mentioned two practical requirements, actually rather trivial though in practice subject to being somewhat neglected, if only because of their time consuming character: 1) existence of a minimal reciprocal understanding of what each participant in the program is concerned with, and 2) clear and concerted definition of the problem to be treated by the programme. Filling these requirements should be done before fieldwork starts in each discipline, otherwise the result is liable to be a patchwork leading to the conclusion that multi-disciplinarity is just a sonorous expression for the addition of independent disciplinary research programmes. Therefore spending some time and money on these topics is a rational 'productive detour', which should be made clear to research financers.

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3.2 Fisheries economics in a multi-disciplinary perspective

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Introduction

Fisheries related activities, be it fishing itself, fish processing, fisheries research or fisheries management form a part of much larger systems. Although this statement is self-evident, its logical consequences may not be always properly accounted for. It raises the question of to what extent can fisheries research or fisheries management rely on results of research in other fields or on generic management in other areas? What makes fisheries economics different from 'other kinds of economics'? What is specific about fisheries management? And what should be the role of other policies, e.g. regional, social or environmental, in relation to fisheries?

Fishing is a part of the human exploitation of natural resources as a cultural phenomenon or as an economic activity. It is affected by developments in culture (social perceptions), technology (electronics), economics (Europeanisation) and prevailing political trends (liberalism, centralisation, etc.). At the same time, commercial fish stocks form part of the general marine ecosystem.

When fishing is discussed as a subject of policy or research, it is essential to determine the scale in terms of space and time. What is the appropriate regional unit - the individual fishing port, the region ... or the EU? And does the discussion reflect a short-term (1 year) or a long-term (10 years) perspective?

This paper deals with research needs in relation to management of sustainable fisheries. The above mentioned broader considerations determine the scope of such questions. Furthermore, sustainability is a matter of perception and value judgement: it can hardly be determined with scientific objectivity. Therefore the research needs will be at least partly dependent on the cultural traditions of the research establishment, as well as the priorities of the stakeholders involved (fishing industry, policy makers, environmental movement, etc.). The brevity of the ensuing paper means that none of the considerations alluded to above can be properly accounted for; the discussion necessarily remains at a rather general level.

Main research themes in fisheries economics

The main research themes in fisheries economics are directly derived from the definition of economics and of fishing as an economic activity or production process. The definition of economics can be formulated as dealing with the allocation of scarce resources, which may be put to different uses.

Fish as a commodity has value (or price) because there is demand for it. People want to eat fish. The level of fish prices depends on the relative scarcity, i.e. on the relation between supply and demand. Supply is determined by the size of the stocks and the production costs incurred in order to bring the fish from the sea to the consumer. This

implies that abundant fish stocks may not be exploited if the costs of fishing, transportation, preservation, etc. are relatively high in relation to what the consumer is willing to pay.

Furthermore, two different perspectives on scarcity can be distinguished: a micro and macro view. The micro-economic view represents the approach of an individual producer. His revenues from fishing (or trading) must be higher than his production costs. He reacts to the actual market prices of all commodities in the short run. The macro-view may be the view of the government or of an independent analyst. This view does not necessarily take the market price as a starting point, but rather the so-called 'economic' or 'shadow' prices. The economic prices are adjusted for different perceptions of scarcity, which may stem particularly from the long-term perspective. The difference between market and economic prices is the reason why, in economic analysis, the key problem of overexploitation of fish stocks is referred to as 'market failure'. Where market prices do not sufficiently reflect the long-term scarcity, i.e. the fact that too high a level of production today (at low prices to vessel owners and consumers and low production costs per tonne of fish) may lead to a fall in production in the future. Buyers and sellers on the market react to supply and demand in the short run, but cannot incorporate possible future scarcity in their considerations and actions. This is fundamentally the reason why economic theory stresses that fisheries management should primarily aim to correct the need for the market failure through a) avoiding any further decrease of production costs (i.e. no subsidies) and b) introducing access fees so that the resource also bears a price for the primary producers.

Fisheries economics in a multi-disciplinary perspective

Sustainability is by definition a holistic concept. Therefore in-depth mono-disciplinary analysis (be it in economics or in other sciences) needs to be complemented by a multi-disciplinary analysis which should clarify the relations between the various aspects like ecology, culture, policy and institutions, technology and the influence of scale in time and space. These relations can be represented in a force field, in which it is apparent that all individual aspects are affected by each other.

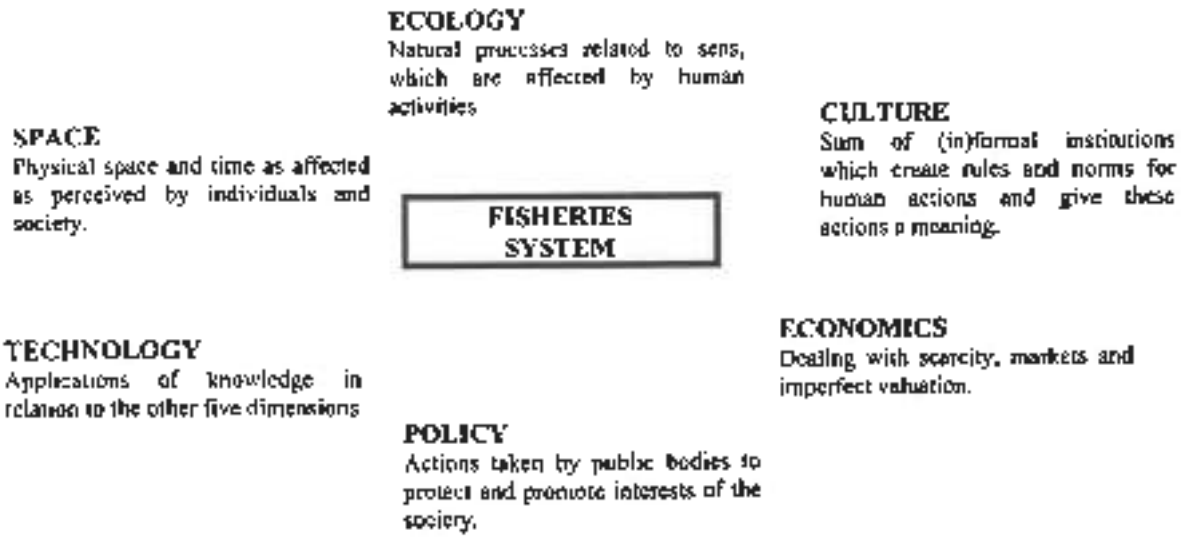

Figure 3.2.1: The force field.

The following sections discuss briefly the relations between economics and the other five 'forces' and indicate the research topics which may be relevant in that connection.

(a) Economics and ecology

View of the world

Fish stocks and fisheries are part of a larger, integrated ecosystem. The philosophy through which man examines this system determines at least partly the scope of analytical conclusions that the economic science may draw. This can be illustrated by two very different examples. The first is the fragmented and utilitarian view, in which man stands outside the ecological system. The natural resources are 'at his service'. Each component of the system is looked at separately, without regard to their links to the rest of the system. If the component cannot be used, it has no economic value. In these circumstances market price does not exist.

The second is the integrated or holistic view. Man is a part of his environment. All components contribute to the proper functioning of the system. Value should also be given to 'existence' and not only to 'utility'. This view forms a background to the 'precautionary approach', which has recently been introduced as a concept in fisheries analysis and management. Taking this view, economic analysis cannot any longer rely on existing 'traditional markets' and on the prices which these markets produce. Correction of market prices and valuation of unpriced 'goods' may be required. The major challenge for applied economic research is the question of 'how to operationalise' concepts like the precautionary approach to make them acceptable to the real economic world, which is governed by market prices. Acceptable operationalisation will offer new instruments in fisheries management: indirect incentives through taxes or subsidies instead of the traditional administrative rules and regulations. These topics are closely linked to 'resource economics' discussed above.

Limits to growth

A major distinction between fisheries and most other economic activities is that the natural environment imposes limits on the size of the industry. A given sea area can sustain only a certain amount of fish. This amount of fish can potentially generate income for a certain maximum number of fishermen. The long-run natural limits cannot be unambiguously determined with the current state of knowledge. This has several consequences for topics of economic research. As the physical basis (stocks) of the sector is limited, greater value added can only be obtained through lower production costs or higher prices of fish. Furthermore, intensive competition occurs as individual enterprises attempt to obtain a 'larger piece of the cake' in order to achieve income growth (race for fish). Distribution of access rights (and thus income) must be addressed explicitly.

(b) Economics and culture

Culture is the sum of formal and informal institutions, which create rules and norms for human actions and give these actions meaning. Fishing is not only an economic activity, but also a way of life in the fishing communities. Cultural factors affect the

decisions of various individuals. A few examples are: competition among fishermen for highest gross revenues, vessels as a status symbol, maintaining fishing despite decreasing income, intergenerational transfers of professional knowledge and skills etc.. These examples show that economic decisions regarding fishing operations, investment and trade may be heavily influenced by cultural factors.

The issues of traditional access to fishing grounds and property rights are also determined by cultural and historical considerations. Economic theory suggests that users of the 'common' natural resources (fish stocks) should pay society for their privileged access to these resources. Even today this seems culturally - or politically - difficult to accept. Open access to common resources leads to the 'tragedy of the commons' and 'free riding' behaviour, processes closely related to market failure. The 'tragedy of the commons' may be considered another major problem in fisheries management.

Common cultural background determines the social fabric of the fishing communities. Common perseverance to maintain such cultural identity may manifest itself in political and economic decisions relating to the continuation of traditional institutions, the maintenance of solidarity in a community and/or commercialisation of relations between people. Economic pressure may cause the disappearance of the fishing sector and lead to a breakdown of the traditional social fabric.

Finally, culture determines, at least partly, consumption patterns. The habit of eating certain species of fish makes fish production commercially feasible. Information about the cultural determinants of consumption habits may, therefore, contribute to broadening of the markets and valorisation of products.

(c) Economics and policy

Political choices

The Common Fisheries Policy (CFP) aims to protect and promote the interests of fishermen, fish stocks, the wider environment as well as the consumers. These objectives may be compatible in the long run, but at any given point in time choices must be made which benefit one objective at the expense of another.

Economic considerations are among the major factors affecting such political choices. Although economics (or any other science) cannot resolve some of the basic problems, economics is capable of producing a consistent set of options to facilitate the selection process. Such options may show which groups will benefit from a given decision and at which point in time, i.e. income distribution. Trade-offs can be made visible.

Management measures

Policy is implemented with specific management instruments - TACs and quotas, decommissioning schemes, mesh size regulations, etc.. Such measures usually involve financial expense. Some measures create rules and regulations and their effective implementation will require a system of control, prosecution and punishment if

necessary. Other types of measures involve incentives intended to stimulate certain forms of desired behaviour (or discourage undesired forms).

In most, if not all, cases, the effectiveness of management measures depends on a large number of factors, influences and incentives to which the fishing companies are subject in the real world. The economic forces play an important role in this respect. Economic analysis can place the management measures in the total force field of economic incentives. Such analysis allows conclusions as to the likely effectiveness of the measures: for example, is the decommissioning premium sufficient in view of economic performance of the fleet. It may also compare the likely effectiveness of certain alternative measures: mesh size v price regulation for example. The analysis may not only shed light on the extent of the desired consequences, but it may equally well explore the undesired ones, which may be just as relevant as, for example, in terms of the creation and distribution of income or employment.

Institutional arrangements

Fisheries policy is not implemented in a vacuum. It is a result of existing institutional and policy arrangements, including the level of government involvement, which institution is responsible for what, *inter alia*. The decision making process is determined by the institutions involved. A specific question in this respect concerns the division of rights and responsibilities between the government administration (EU - national - local) and the industry's own organisations. Different institutional arrangements may differ in terms of their economic efficiency.

(d) Economics and technology

Competition between companies is the driving force behind ever increasing technological efficiency. The physical environment imposes limits on the total potential volume of production of wild caught fish. Competition occurs either through higher prices (valorisation through better quality in the broadest sense) or lower costs per unit of catch. In both cases the financial productivity (value added or income) per unit of costs will increase.

Productivity increase is usually achieved by replacing labour by capital. The required investments create new jobs on shore but lead, at the same time, to a loss of jobs onboard. Techno-economic research may demonstrate the acceptability and economic consequences of certain technical measures.

Technological development is not necessarily purely technical. It may also affect the organisational aspects of the firms as well logistics in the whole chain.

(e) Economics and spatial and temporal considerations

Autonomous economic development as well as fisheries management policies lead to changes in the structure of the industry, the characteristics of employment and income distribution. These changes occur in space and time. The dynamics of the system allows some groups of fishermen or regions to become prosperous, while others are obliged to leave the industry and look for new economic activities. Such changes take

time. Furthermore, some generations may benefit more from the available fish stocks than others. The choice between less fish now and possibly more in the future is well known in fisheries.

Future information needs

Future information needs will be derived from the approaches taken towards sustainable fisheries management. It is increasingly recognised that sustainability cannot only be interpreted and/or achieved by accounting for the biological phenomena. The objects of fisheries management are people and their organisation. Biological and ecological information is essential as an indicator of the constraints of the system which need to be respected. However, it provides little information when it comes to the measures which need to be taken. The foregoing discussion indicates the large variety of information, which may be required from mono- as well as multi-disciplinary analysis. An area, which is already coming to the forefront of policy attention, is the *relation between economy and ecology*. In the search of win-win situations it can be expected that the trade-offs which may occur between economy and ecology will drive the direction of the research in the coming decade. Three types of information needs (and research) could be distinguished:

* provision of 'raw data' (monitoring)
* elaboration of analysis (assessment)
* contribution to solutions (advice)

These three issues are discussed briefly below:

Monitoring

Collection of data is the basis for all empirical research. Consistency and reliability play an important role in this respect. In view of the links between stocks and markets, interdependence of stocks, the role of fisheries at various levels in the economy, etc., it is necessary to collect data on fisheries on a relatively broad scale. Economic data about fleets need to be supplemented with information about related industries and trade, the dynamics of the regional economy, etc.. Stock management measures may have consequences in this area, which would not otherwise be foreseen.

In some cases it may be useful to co-ordinate the data collection regarding socio-economic and biological indicators. This may be particularly the case when the data should serve as a basis for bio-economic models. Consistency of such data in terms of scales in time and space, classification of catches and landings, unit of fishing effort, etc. must receive appropriate attention.

It seems equally relevant to follow the development of the qualitative conditions: adherence to rules and regulations, institutional capacity for enforcement, investment trends, creation of employment opportunities, etc.. Advice on fisheries management will have to look particularly well at the behaviour of the various 'actors' - vessel owners, processing industry, professional organisations, etc.. Analysis of the 'tragedy of the commons' and the 'race for fish', requires qualitative information in this respect

because it improves the understanding of the driving forces behind observed behaviour and it allows a better interpretation of the collected statistics.

Quantitative information needs to be collected regularly and consistently in order to avoid conclusions based on non-representative data. Qualitative indicators are less subject to discontinuities and may be collected with *ad hoc* surveys.

Assessment

Analysis of trade-off's between economy and ecology mainly concerns the considerations in short and long runs respectively. The economic survival of firms may be evaluated on time scales of months and years. However, ecological sustainability is determined on the scale of decades and more. It is therefore crucial to develop methodologies which can account for these differences and be accepted by the various stakeholders - the fishing industry, policy makers and environmental protection organisations included.

Major factors which need attention in this respect include *inter alia* uncertainty about future stocks / caching opportunities (stochasticity) and the valuation of unpriced goods (what is the price of environment?). This second issue is well known from other areas of economics such as environmental and development economics, so that experiences from these areas may be relevant for fisheries.

The aim of assessment is to determine where there are trade-offs between economics and ecology, to put these trade-offs in an analytical, or policy relevant, framework, and to quantify them as far as possible. The analysis should identify the driving forces behind such trade-offs in order to allow for the proactive formulation of policy measures and to identify win-win situations when it comes to advice.

Advice

Social science research, including economics, should be able to provide advice in relation to the question: 'how can the behaviour of the various stakeholders be affected in a desired direction?'. The assessment should offer the necessary understanding of the interests and the driving forces of the stakeholders so that the policy advice may be related to them. Proper understanding of behaviour is essential in this respect. Not only the behaviour of producers is relevant here, but also that of other stakeholders - policy makers, environmental organisations, etc.. These stakeholders have their own interests, although sometimes the impression is created that they pursue the 'interests of society' at large. An example may be the fact that the Council of Ministers is itself regularly involved in a 'race for fish' by pleading for higher TACs or economic support to the industry.

Advice-directed research should also pay attention to the negative, or undesired, consequences of proposed measures. Practice shows that the solution of one problem may lead to the appearance of another problem elsewhere. Although, not everything can be foreseen, indications as to possible new problems can often be given. This is a particular area for multi-disciplinary research because of the transferability of problems into another dimension.

Research in itself is unlikely to lead to final solutions. There is almost always a need for political choice. Research can support or clarify such choice. Therefore attention should be given to the application of scenario analysis and the specification of the variables which should have a central role in the scenario. Scenarios are not forecasts. They can improve our understanding of possible future developments. They offer a framework for evaluating the likelihood of various options and most effective remedies (e.g. the kind of measures which may have positive effects in many different situations).

The proposed solutions will have to be consistent with the general development of society, as otherwise they may be unacceptable. Therefore today the perception of the 'environment' will play a major role. The operationalisation of the 'precautionary approach' will be one of the major challenges of research in the coming years.

Research needs and organisation at 'meta-level'

Limitations of scientific research need to be recognised, particularly in the short run. The sustainability of fisheries will remain a matter for discussion for the time being because of our limited knowledge of the ecosystem at large and the impossibility of ever being able to deliver final and conclusive knowledge. Therefore scientific research should pursue a more humble role than looking for the ultimate truth. And the users of the research results should take this into account.

The scope of research outlined above goes somewhat beyond the traditional approaches. New questions need to be addressed at the meta-level in relation to form and content of a possible future research agenda:

Content - what should be studied?

- Multi-disciplinary theory of fisheries
- (Holistic) indicators of sustainability
- Consolidation of scales in space and time
- Sustainable behaviour of individuals and institutions

Form - how the research should take place?

- Cooperation of social and natural sciences
- Dialogue with users
- Exploitation of all knowledge

Content

Setting up comprehensive multi-disciplinary cooperation should complement the ongoing mono-disciplinary research. Such cooperation can only be effective if it takes place within a framework (or theory) to which all participants can relate. Developing a multi-disciplinary theory of fisheries is therefore a first priority. Such an initiative would also benefit many other fields relating to environmental issues. This theory should lead to a definition of practical indicators of sustainability. It can be expected that these indicators will also have a bearing on various dimensions of the force field

described above. A major characteristic of these indicators will be the feasibility of their communication to the involved groups (fishermen, consumers, environmental interests groups, etc.). The indicators will have to be accepted and respected by these groups.

One of the major problems in reconciling the economic needs of the industry and the ecological regeneration of fish stocks is the different scales in space and time which characterise them. Other time scales can be found in the areas of political decision making or shifts in consumption patterns. Research into the short- and long-term priorities of the involved stakeholders may provide indications as to how greater consistency can be achieved and how human actions should be adjusted.

Related to the above points is the question of sustainable behaviour among individuals and institutions. The 'tragedy of the commons' is not only characteristic of the competition among fishermen, but also in the international political arena, in technological competition, etc.. Research needs to be carried out into the cultural habits and institutional arrangements which maintain (or could contain) undesirable competition for scarce natural resources. A specific question in this respect concerns the practical operationalisation of the precautionary approach in the realities of every day life.

The high dependence of the EU market on imported fish products, along with general worldwide trends in fish production and consumption, calls for intensive scientific effort to develop economically feasible, culturally acceptable and ecologically responsible large-scale fish farming. This effort should offer the EU consumers traditional as well as novel seafood products. Although fish farming does not have to take place necessarily in the EU, it must not develop at the expense of the environment elsewhere (e.g. the destruction of mangrove forests for shrimp farming).

Organisation / form

The force field shows clearly that each topic has to be addressed by the natural as well as the social sciences. Effective multi-disciplinary cooperation will require appropriate organisational arrangements. It does not seem likely that cooperation can come about just through *ad hoc* projects or meetings. This would not be considered sufficient in mono-disciplinary research either. Specific proposals need to be developed as to the possibilities of effective organisation of multi-disciplinary research.

Dialogue among the disciplines needs to be complemented by ongoing structured dialogue with the users of the research results. One of the most important and most difficult steps in applied research is the proper definition of the research question. In practice it appears that such questions cannot be formulated either by the users or by the scientists alone. Formulation of the right question already contains the nucleus of the required answer. This answer is to be applied by the users to specific problems. Close involvement of the users in the research process is a guarantee that they will recognise the value of the research outcomes and will be more willing and capable of using them.

Finally, it should be recognised that among the various groups involved there is a vast, often dormant, knowledge. They have a potential to provide additional information for research purposes. Attention should be given to a more intensive cooperation between research and the fishing industry (and others) in order to use all available knowledge. The fishing fleets, for example, could provide a large variety of information in real time. Many fishermen have developed in-depth understanding of the environment in which they operate. Today this knowledge is discarded as unscientific.

Final remark

Fundamental as well as applied research is a risky enterprise. This is even more the case when new experimental approaches need to be followed. The priorities set out in this paper certainly contain a fair amount of risk. Very specific results probably cannot be expected in the short and medium run. Allocating resources to this need today is the only way to obtain the required knowledge during the start of the next century.

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3.3 Multi-disciplinary research on the sustainable development of the fisheries sector from a market perspective

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What is sustainable development of marine fisheries?

According to the invitation to this workshop, we are asked to provide answers to a number of questions. The overall question is 'what are the research questions that have to be answered if we are to achieve management systems which can guarantee the sustainable development of marine fisheries?' Our collective aim, therefore, is to attempt to answer this demanding question from the different fields of professional and technical knowledge that we each represent. This is an impossible question to answer but if we can come a little further along the road then I shall be, if not exactly satisfied, at least a little happier. We are all invited here because of particular interests and experiences in fisheries management and maybe also because we harbour some particular doubts or criticisms concerning the track records of our own disciplines.

All known systems of fisheries regulation are inevitably a reflection of certain power relations within the society from which they are derived. The results are the political consequence of certain group interests and the influence of prevailing fields of knowledge, like biology and economics. But we can also recognise that there are other concerns which are only marginally represented or ignored altogether. The dominating influences also differ from one region to another, according to their social histories, the overall development of their economies, the particular characteristics of the fisheries and so on. These factors and their social acceptance serve to reduce the common denominators in fisheries regulation.

It is impossible to include all relevant concerns in a single system of fisheries regulation, constructed according to simple and workable basic principles. But we should try to include all essential concerns. We can probably agree that there are many such concerns (see Jentoft, 1993) deeply affected by fisheries policy and regulation, but we would be unlikely to agree on how these concerns should be evaluated and prioritised. Some important questions we are simply unable to answer. I cannot, for example, evaluate future regulatory regimes in terms of the relative weight given to the conservation of fishing communities or the role of different sectors of the harvesting industry - whose futures may well depend on precisely how the regulatory systems are structured. This is a major problem - not only for social sciences, but also increasingly recognised by economists and biologists.

It is important that we clarify our understanding of the concept of 'sustainable development', if only to avoid the situation where each researcher works within their own private definition. Maybe we cannot reach agreement, except in very vague terms. But there is nothing intrinsically wrong in working with an imprecise but generally agreed interpretation. After all, as Herman Daly (1996) points out, some of our most important and valued concepts prove difficult or impossible to define in an

analytically precise way. Think only of concepts like democracy, equality, justice or welfare: 'sustainable development' would be a worthy member of such an elite club.

As a point of departure, we might consider the original broad concept of sustainable development, as enunciated in The World Commission on Environment and Development's 1987 report *Our Common Future* and built around the trinity of the natural environment, economic growth and social development. Comprehensive as this is, it does not give us much of a lead for deciding on what kind of management system for fisheries. The FAO's *Code of Conduct* (1995) is not all that more helpful in this respect. It is a hard task to define the essential characteristics of 'good' management, partly because of the prerequisite that management systems should be designed to suit particular ecological, cultural and social conditions (Symes, 1999: p. 5).

Will better management of fish stocks and of the marine environment automatically mean better conditions for social sustainability? Will better management afford better conditions for fishermen or fishery dependent communities? The experiences from Greenland would seem to show the opposite. The Greenlandic fisheries administration introduced an ITQ system in 1990; since that time, the problems of overcapitalisation have disappeared with now only 30% of the seagoing trawler fleet left catching the same amount of shrimps. The new system means that the resource is mainly left to the large trawler companies to exploit. As a result, the settlement structure is under great pressure and many of the fishing dependent communities are in the process of disappearing. The same phenomenon is occurring in Iceland. Does this then mean that 'better' management does not necessarily imply social sustainability? Or does it mean that the ITQ system does not represent 'better' management?

Is the small-scale fishing fleet - the basis for many fishing dependent communities - more sustainable than the large-scale deep sea fishing fleet? There is a burgeoning literature examining this issue from both sides with conflicting conclusions emerging from different standpoints. Maskell *et al.* (1998) and Arnason (1996) are in favour of large-scale fishing, while Apostle *et al.* (1998), Hallenstvedt and Søvik (1996) and Kurien (1999) favour the small-scale fisheries. The former group of authors make their evaluation based mainly on the ability of the large-scale fleet to create economic surplus, while the latter group give more weight to intangibles like the 'way of life' and the cultural aspects of fishing communities. The real problem for me is that I cannot think of any management system that will not be seen to favour one side or the other in this dispute.

The food chain in the fisheries sector

Now perhaps I can offer a few comments on my own particular field of research activity in fisheries which may broadly be described as the relations between the rapidly changing fisheries sector and the fisheries dependent regions. Changes in the fisheries sector may have several different origins - fisheries policy, user-producer relations and the changing markets for fish. Today, I am expected to represent the links between the fishery and the market.

In a newly published bibliography of fisheries social science (Vestergaard, *et al.*, 1998), this particular research area was described in the following words:

> "A major gap in the international literature of fisheries social science is analysis of the influence of the downstream sectors (processing, distribution, retailing) on the harvesting sector. ... In this, fisheries social science today mirrors the conditions of rural sociology in the 1970s and 1980s when change in agriculture was almost exclusively interpreted in terms of internal dynamics. Endogenous explanations of social change were privileged and exogenous factors neglected. Unlike rural sociology there has been little or no awakening to the powerful influences exerted by the downstream sectors of the food industry and to the impacts of the globalisation tendencies of production and marketing in the fishing industry."

The sustainable development of regulatory systems in marine fisheries certainly concerns the consumers in large measure. They are, after all, by far the largest group with legitimate interests in the fisheries and in securing the sustainable utilisation of the living resources of the sea. Consumers are demanding the introduction of regulation systems which would exclude all forms of discards. This was a very clear result from a consensus conference held in Copenhagen in 1996 (*Fremtidens Fiskeri*, 1996). The conference also made clear the consumers' demand for systems of regulation that would prevent the landing of large quantities of fish in poor condition which yield an inferior product or end up in fish meal plants.

In this connection it should be noted that even in Denmark - the EU's major fish exporter and a country with nowhere more than 50 km from the sea - it is difficult for consumers to buy fresh fish. Consumers today want quality assurance, with labelling indicating the time and place of both catching and landing of the fish, as for any other kind of food.

The most important goal, therefore, is to ensure that as much as possible of the catch reaches the consumer in the best possible condition and that the fishermen receives a price which properly reflects the quality of the product. For the fisherman a 10% rise in price based on quality improvement would mean much more than a 10% increase in catch volume. Such a goal requires research into all of the links involved, including fisheries management, the fishermen's organisations, the first-hand sales institutions and the various logistical institutions, the retail sector with its super- and hyper-markets, the globalisation of the fish trade and quality labelling to mention only some examples. All these links and institutions are undergoing constant change - some at a very high rate and some to a lesser degree. Of particular interest are the new interfaces developing between the different actors located within the production chain - upstream as well as downstream - where knowledge based activities provide a particular focus (Jentoft *et al.*, 1999; van Vliet and Friis, 1999; Friis and Vedsmand, 1998; Friis, 1994; 1996).

Some of the key questions for research to answer in this field are:

* FAO statistics show a remarkable growth in the sale of fresh fish. How can we create first-hand sales institutions that will prevent the delay of fresh fish

reaching the market? What are the shortcomings of the existing institutions? What are the social and regional consequences of IT-based, first-hand sales institutions like Infomar?

* How do we define quality as seen from the consumers' point of view and how do we measure these parameters and certify them? In many European countries, consumers are demanding reliable labelling which describes the quality of fish and fish products. According to some studies, consumers are willing to pay more for fresher fish. The market therefore requires a much wider differentiation of quality parameters that can be documented in a reliable way. Which links in the food chain should take the initiative in developing this?

* How do we strengthen the lines of communication between fishermen and consumers?

* How is value within the fish chain in Europe distributed among the different links? Are all the links necessary? Indications are that fishermen receive only 20% or less of the end price paid by the consumer. A reliable survey is needed at a European scale to identify the middlemen and to discover who takes what out of the end price.

Other topics which lie outside this food chain approach to fisheries research would include some assessment of the ways in which fishermen's organisations in Europe can be developed so as to make them ready and able to take on more responsibility in relation to fisheries management, and a comparative study of the welfare distribution effects of different regulatory systems in fisheries.

Identify gaps in knowledge of fisheries and their management

Personally, I have a rather large number of gaps in my knowledge of fisheries and their management, but I have only been working on such issues for 25 years. Most of these gaps would turn out to be very different had I been working in a different disciplinary context. Prediction is a difficult art, especially - as a Danish humorist once put it - when it concerns the future. But the truth of the matter is that gaps in our knowledge and understanding are being continually reproduced by the pace of change affecting the fish chain *per se* and by contextual changes in political, institutional and global conditions.

But there is one particular gap that deserves special attention. The primary role of fisheries regulation has been to limit inputs into the fishery, according to the existing state of resources. It has only been a secondary function to examine the distributional effects of such actions, as between different regions or different segments of the fishing industry. I would like to see the distributional function of fisheries policy given more prominence - which regions (and sectors) are privileged and which are deprived as a result of policy decisions. Fisheries management can be seen as a way of distributing welfare which can have very significant economic consequences for fisheries dependent regions. For such regions, some form of preferential treatment - or positive discrimination - concerning access to resources may be of much greater future

value than the various forms of income transfers and regional subsidies that exist today.

Filling the gaps through a multi-disciplinary approach

Existing disciplines and their scientific theories are less and less able to provide solutions to problems which are becoming ever more complicated. Most real world problems cannot be solved within a single discipline. For me there is no doubt that we need to practise multi-disciplinary research. The only questions are how and in what kind of organisational framework.

Most disciplines in the natural and social sciences are becoming increasingly narrow minded, mainly because of their institutional frameworks and their path-dependent incentives. Much academic work has until recently been looking too much to national definitions of problems to be answered. The most crucial problems today are those for which domestic solutions are insufficient. The ESSFiN workshops have demonstrated that multi-disciplinarity by itself is not enough: it is important to achieve the collaboration of researchers from different localities, regions and countries and from fishing dependent regions as well as from fish importing regions.

I therefore tend to agree with the Gulbenkian Commission (Wallerstein *et al.*, 1998) on their proposals for the restructuring of the social sciences and its advice on attaining a higher level and better quality of inter-disciplinary research. This would involve:

(i) building or expanding institutions within and outwith universities which can bring researchers together for at least a year to work in common on given important themes; it is important that such groups of researchers are well prepared before they begin their common research but that they retain sufficient 'discrepancies' in their understanding in order to encourage a fruitful exchange of views and of knowledge;

(ii) the establishment of integrated programmes of research cutting across traditional disciplinary boundaries and working towards specific goals within a given time scale (e.g. 5 years); the *ad hoc* character of such programmes could create a framework for constant experiment;

(iii) dual job designations for teachers in higher education, involving a structure where all teachers work within their own institutes according to their disciplinary training, but also in other areas/institutions according to their interests; this could result in many interesting combinations of multi-disciplinarity;

(iv) multi-disciplinary education at undergraduate level - students should be trained to use different disciplinary approaches and methodologies for the solution of carefully formulated problems.

I work in a university where nearly all learning takes place in groups and in which the students select a problem that they wish to solve or where they may discover the

reasons why they are unable to find a solution. They are required to involve theories and methods of different disciplines in their search for a solution. Although we have a range of disciplines available within both the natural and social sciences, students must elect to follow two of these disciplinary streams. Thus a mono-disciplinary training is not an option.

I believe future generations of researchers will be more at ease - and more successful - with the notion of multi-disciplinarity than we are. It may be that international, inter-disciplinary research projects are both difficult and expensive to establish, but from my experience once the basic personal network is in operation it is relatively easy to develop a project and discipline boundary problems become only a minor problem. Finally, it will be necessary to base future research on fisheries and their management not only on a broad, international network of sciences, but also on developing close relations with the industry as an equal partner, if we want to succeed with the agenda of sustainable fisheries.

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3.4 Multi-disciplinary research in fisheries management: the interface between science, government and the industry

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This short paper addresses three very different issues of interest to the fishing industry: the communication and organisation of decision making; coastal fisheries; and nature conservation. Multi-disciplinary research might be useful in all three.

Communication and organisation

It is certainly not news to say that the communication between the fishing industry, politicians and scientists concerning fisheries management can and should be improved. Of course there is communication between these groups. But when I consider the communication between the European Commission and the fishing industry - although there is a form of regular consultation - a clear procedure that involves the fishing industry in the decision making process is lacking.

An important example is the annual problematic discussion about the report of ACFM. This is a biological report but it contains important political aspects. However, the fishing industry is not involved in the process of drafting this report. Almost every year the industry is surprised about the stock assessment of one, two or more fish stocks. The fishermen present information or views that conflict with the information of the biologists and a dispute arises. Often there is very little time for the fishing industry to influence the political decision making process. As a consequence, the industry is normally dissatisfied with the results of the process and this often leads to insufficient support for the resulting management measures. I would be very interested in the results of research on the possibilities for improving the communication and organisation of this process, and especially the closer involvement of fishermen. This research should be multi-disciplinary since it would at the least involve biologists, social scientists and economists.

May be I can offer the scientists some general advice. Since there are now so many research reports, it is impossible for managers to read them all; it may be that some managers read none at all. Therefore scientists working in fisheries should pay more attention to the communication and presentation of their results to the fishing industry, formulating the key points from their findings briefly and in simple language. Fishing newspapers can be very useful in this respect. The presentation of simplified clear summaries has more impact on policy makers. The possibilities of the internet for presenting scientific results to politicians, fishery managers and fishermen should also be investigated.

Coastal fisheries

In the discussions on fisheries management, coastal fisheries occupy a special position. With the revision of the Common Fisheries Policy and the structural policy,

further concessions to small-scale fisheries becomes an issue. At the moment measures to protect or stimulate coastal fisheries include the exemption from filling in a logbook, and extra subsidy payments within the framework of the EU's structural policy. In my opinion it is questionable whether this is a wise policy. Even vessels under 12 m may have up to 300 hp capacity through the use of powerful outboard engines. These vessels are often well equipped to catch considerable amounts of fish. The technological progress in coastal fisheries should not be forgotten. Measures to protect the coastal fleet can also be detrimental to the local fish stocks and to the nursery grounds of commercial species.

The plaice box is a good example, although the measure was not taken to protect coastal fisheries but to protect undersized fish. The plaice box has been closed to fishing vessels with a capacity over 300 hp for some years. The Dutch beam trawl fleet supported this measure since it was intended to result in the protection of juvenile sole and plaice and encourage less discarding. Biologists promised higher yields of flatfish in the future since the fish would be given more time to grow. However none of the latter happened, most probably because the capacity of the fleet of smaller vessels fishing in the plaice box doubled. The plaice box is therefore realistically an example of a measure to protect coastal fisheries. Stocks did not improve; indeed, the opposite happened. It would be very interesting to know who benefited from this measure and whether or not the coastal communities were the net beneficiaries.

Nature conservation

Research into nature was and still is mainly the domain of biologists. Until some years ago almost all research effort was concentrated on stock assessment. However, the effects of fishing on the ecosystem have recently received more attention. In 1997 the Intermediate Ministerial Meeting on Fisheries and Fisheries-related Species and Habitats issues was held in Bergen, endorsing the further development of the precautionary principle and the ecosystem approach. This development still involves biologists. But as I see it, the development of these two approaches involves important political themes, which cannot be left solely to the biologists. Politicians have to set the objectives. But how are they going to do this? And how will the fishing industry be involved? What kind of economic or social consequences will an ecosystem approach have for the fishing industry? The effects of conservation measures on the industry are often neglected or assumed to be inevitable. But the consequences may be much more serious than many people expect. Insufficient attention is being given to marine infrastructural developments (windmill parks, port extensions, new airport proposals). How do these measure up to the marine conservation objectives and how do they fit within discussions about the precautionary principle and ecosystem management? These are important questions for multi-disciplinary research.

3.5 Discussion

Torben Vestergaard (University of Aarhus, Denmark). Once again we seem to be talking about a paradigm shift, which involves a move away from reductionism towards a more comprehensive and reflexive mode of analysis. Rather than identify specific research themes, the first step is to identify how each discipline (in this case economics) perceives itself in relation to other disciplines and in relation to the fisheries system. Management and research are part of that system so that context and self-reflection are important. But if the move is towards holism as the new paradigm, then we have some additional problems. We may rid ourselves of some problems of generalisation but structured rational systems are difficult to compare. The political reality is that we should be able to standardise and generalise regulations and compare the results throughout the 'common pond': this is made more difficult when taking a holistic approach. Moreover the fisheries system still looks very different depending on the disciplinary perspective. Salz' force field is not a homogenous nor a level playing field: some components are more like ends, means, costs, gains and parking lots for disorder. We need to clarify how to structure the force field between disciplines.

Christian Lequesne (CERI, Paris, France). It is interesting to consider how science is perceived in relation to the political process. When thinking about a paradigm for research, we need to consider the scope for discourse with the political, administrative and social actors. Legitimate discourse would include complexity and multiple interests. Interestingly economists now insist on the need for links with the marine ecosystem, behavioural patterns etc.; this is the same discourse as the fisheries biologists are now seeking. Whilst I can understand what a multi-disciplinary approach to fisheries management entails - basically an understanding of what other disciplines are doing - it is less easy to understand the notion of a multi-disciplinary science of fisheries management: science implies a common language and common methodological approach - multi-disciplinarity is surely not aiming for a common approach.

Euan Dunn (Royal Society for the Protection of Birds, UK). Fisheries managers (and environmental managers) are increasingly faced with a barrage of information and an overload of scientific reports. The industry needs to think how it might better interpret the available information, improve its capacity to create its own advocacy and grapple with the dissonance between short and long-term goals. Much of our discussion of paradigm shifts and research agendas is related to a medium-term - if not a long-term - future, but most of the current issues relate to a much shorter time scale. The CFP review, Agenda 2000, structural fund reforms etc. are all happening now. Research findings are often too late to influence these events. The dialogue between fisheries (economic) interests and environmental (conservation) interests has not yet taken place at the institutional level and there is little evidence of a meeting of minds within the Commission. Do we need - as one presentation at the recent ICES meeting argued - a single committee on environmental and fisheries advice? Although fishermen may argue that they have problems with consultation, other interest groups find that the main committees (e.g. ACM) are already stacked in favour of the producer sector.

Open discussion stressed the following points:

(i) The divergent time scales of basic research, scientific advice and the urgency of policy decision: despite the 2002 revision the industry still has to face ongoing changes in resource allocation, monitoring and market policy. Blue skies research does not relate to the daily environment in which fishery managers must take decisions. We have converging streams of biological, economic, technical, social and now environmental research and advice, but we lack effective means of coordination and overall evaluation. Who should be given this task?

(ii) The need to look more carefully at what can and should be done in terms of research; in other words we need research on the research process and the way it connects to the management process. The latter has tended to force scientific research into short-term predictions. Maybe we are pretending that scientific research is doing something which in reality it cannot do: biological advice, for example, is being used to provide a platform for political negotiation, but is it merely providing a scapegoat for those who should be taking the decisions? Biological advice has become part of the political process. Science has been incorporated within the political system. It is, therefore, no longer disembedded from its social context. What 'political' processes are causing this to happen? How do we create valid knowledge for use in a more transparent system?

(iii) The need to look at the 'balance of power' between the disciplines as a starting point for multi-disciplinary research and at the ways of exerting not more but better balanced influence on policy making - through increasing sophistication of models, through more information gathering or through the development of a science of coastal management.

(iv) The need to broaden the analysis of costs in fisheries; at present we take a conventional but narrow view of the costs and benefits of the fishing industry and of different management options. If we were to cost the ecosystem impacts of fishing activities then the results of the cost-benefit analysis would change significantly. Costing the environment is a difficult but important task.

(v) We seem to be arguing both that scientific research is the product of the institutional form of fisheries management and also that current fisheries management is the product of how scientists do their research and how they offer advice. We must, therefore, break the two moulds - academic and institutional - simultaneously and find ways of disrupting the self-perpetuating mechanism of routine research and management decisions. But most scientists and most administrators feel more comfortable and more secure within the existing framework. Who is to act as the catalyst for changing the system - the administrators, the scientists or the fishing industry?

4.0 SOCIAL SCIENCE PERSPECTIVES IN EUROPE AND NORTH AMERICA

4.1 Multi-disciplinary research: an anthropologist's view

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Introduction

Multi-disciplinary research in fisheries management, or in any other field, needs to find out how disciplines can benefit from each other. The advantage is that between them more disciplines can cover more empirical ground. The difficulty is that between them there are fundamental differences of outlook in terms of theory, epistemology and method, and there are different institutional traditions (relations with authorities, industry, pure research, applied research etc.). Research themes differ accordingly, not just between disciplines, but within disciplines.

Anthropological research themes: relativity and reflexivity

Since Malinowski made it famous, long-term fieldwork has been the *sine qua non* of social and cultural anthropology (Malinowski, 1922). As long as that applies, two perspectives will necessarily be emphasised in anthropology: *relativity* and *reflexivity*. Relativity and reflexivity have been root causes of major research themes in anthropology for a long time. It applies today to research themes relevant for fisheries management, and it matches some contemporary trends, which may be a mixed blessing.

Relativity and research themes

To do long-term fieldwork is to study social or cultural phenomena in their living context. It implies the understanding or explaining of phenomena relative to their particular context, as parts of a whole, hence relativity or holism. Long-term fieldwork in a limited area would have to make things appear in the light of the social or cultural systems of which they are part. The relative emphasis on either social relations or cultural meaning varies with theoretical idiosyncrasies, but in either case the ambition has been to demonstrate that phenomena make sense as parts of a system; that they are rational in terms of the logic, meaning or functioning of the system.

If the theory is that parts fit into wholes, that is what you will expect to find in research. The critical observer might here identify a conservatism or an equilibrium assumption that produces coherence and meaning wherever it is applied. The assumption of equilibrium or closed systems cannot stand unchallenged today, neither in anthropology nor in economics or biology. Such assumptions have, however, made a lot of sense for anthropology in the face of policy interventions that used to expect

only irrationality (lack of meaning, system or efficiency) outside of the domains controlled by rational administrations or the market.

Relativity translates into holism, which is a fashionable term with a number of meanings. I refer to holism as a theoretical perspective on the research object, not as a norm for the research subject that would allow the confusion of truth and value ('is' and 'ought'). Holism is anti-reductionism. In a weak form it insists on context. In a stronger version it requires values to be counted among the social facts that should be systematically included in the theory of social systems and not just mobilised *ad hoc* for occasional use in explanations.

One of the stronger expressions of holism in anthropology is that of Marcel Mauss in his book on 'the gift'. The gift is described as a 'total social phenomenon' which is at the same time economic, political, juridical, moral, religious etc. (Mauss, 1990: p.3). Gift-giving is not just related to the whole in the way that any social phenomenon is related to its context. Gift-giving implies the social condition as a whole, a social phenomenon inseparable from religion in Durkheim's sense (Durkheim, 1971). The legacy of Mauss is an invitation to study any social institution, economic, political, industrial etc. as a moral fact and not just a practical function.

The term 'embeddedness' has a somewhat similar meaning though with an emphasis more on context than on value. It was a key concept of the economic historian Polanyi, and it will be known outside of anthropology (Granovetter and Swedberg, 1992; Polanyi *et al.*, 1957). 'Embeddedness' expresses the holism or relativity that characterised so-called substantivist economics. Polanyi saw the economy as society's material maintenance processes instituted in social forms inseparable from the concrete social context. His position was formulated in opposition to a formalist definition of economy as 'the allocation of scarce resource to alternative ends', an understanding much better adapted to less contextual model building (Burling, 1962). Both trends had their adherents in anthropology, but the conditions of the debate was in a sense set by the substantivist position: anthropologists inspired by neoclassical economics or game theory would have to prove that they could incorporate consideration of social and cultural context. To consider social and cultural context is still an anthropological requirement, but not enough. The ambition also includes the demonstration of the rationality, in one sense or another, of institutions as parts of a wholes.

Some of the research themes that have been interesting relative to fisheries management could be summarised under the headings of *social organisation* and *cultural tradition*, respectively. The former is the study of the social organisation of fisheries practices and rights relative to a variety of management relevant issues like economic rationality, ecological adaptation, or the meaning of life. The other is the study of cultural categories or local knowledge of marine environments and technology relative to the same management issues.

Some of the studies of social organisation are written into the debate on the 'tragedy of the commons' (Hardin, 1968; Scott Gordon, 1954). The 'tragedy' approach shares with the so-called 'formalist' approach a notion of social systems as aggregates of self-interested short-term actors. This premise foreshadows the conclusion that

resources held in common will be ruined in a race for gain unless state or market forces are brought into play to prevent it. The obvious challenge to an anthropological approach has been to inquire into the rationality of customary organisation of fisheries as viable alternatives to modern management intervention whether state or market based (Cordell, 1989; Eythorsson, 1996; McCay and Acheson, 1987; Pálsson and Pétursdóttir, 1997).

Overlapping the studies of customary management are studies of the social organisation of fishing relative to the ecological conditions. Some are successors to classical cultural ecology studies of ecosystem adaptation (Steward, 1955), but also to more recent studies of coping with risk and uncertainty in ecological and economic environments (Berger and Piore, 1980; Smith, 1991). The risk and uncertainty studies have implications for the 'tragedy' discourse, because the latter is premised on resources with simple, predictable dynamics. The question is, then, whether customary institutions have advantages over designer institutions in adaptability to non-equilibrium environments. In an admirable monograph on life in an Asturian fishing village Sánchez Fernández (1992) has analysed the relationship between social institutions and the risk and uncertainty of living from a marine ecosystem. Acheson and Wilson have, separately and together, dealt with uncertainty and unpredictability as fundamental ecological and economic conditions that fisheries institutions must cope with. (Acheson, 1988; Wilson, 1980; Wilson *et al.*, 1994). An outcome of this line of research is the indication that modern management systems may in fact lack qualities that customary systems have, for instance the ability to function sustainably on the basis of very imperfect knowledge.

Apart from the practical perspective, this research theme allows us to illustrate a difference of some consequence between disciplines that have otherwise shared the assumption that they studied equilibrium systems. Anthropology, economics and biology have studied social, economic and living natural systems, respectively. The interesting point is that they have had a widely shared premise that these systems were equilibrium systems. Correspondingly, the source of disorder and its destination when disposed of would tend to lie outside the social, economic or natural systems, respectively. It would be an expectable consequence of disciplinary equilibrium models that disequilibrium originates in the domains of other disciplines. So, it was perhaps to be expected that anthropologists would, rather sooner than biologists, take up the idea of chaotic ecosystems, since that was where disorder was likely to come from anyway. We may be more prepared to accept new perspectives outside our discipline than inside it.

The division of the world into exclusive disciplinary worlds seems to be giving way to greater openness, at least when judging from conferences and research projects; it may be different when we get closer to the domains where disciplines enjoy particular privileges. Whether the apparent openness is a result of progress in research or of unreflected or opportunistic drifting with popular trends is another matter. Both anthropology and economics have for some time made efforts to include the natural environment in what they study. One good reason would be that the environment has political priority. Another reason is the post-modernist settling of scores with Cartesian dualism, especially the nature/culture distinction (Hornborg, 1996).

Studies of local knowledge have a background in the long tradition of cultural classification studies. In Europe such studies generally trace their ancestry to Durkheim and Mauss (Durkheim and Mauss, 1963; Lévi-Strauss, 1962), whereas the US has a distinctive tradition in cognitive anthropology that includes famous studies such as Conklin's on the plant classification of the Hanunoo in the Philippines and Gladwin's on Micronesian navigation (D'Andrade, 1995). These studies have dealt with knowledge as essentially social or cultural systems, respectively.

The explicit recognition of local knowledge in the Rio Declaration has encouraged research initiatives in the study of local environmental knowledge (Inglis, 1993; Sillitoe, 1998). A theme in the present debates on local knowledge is the admissibility of taking local knowledge out of context. One position is based on a theoretical argument, the relativity issue, that things are what they are in context, particularly if we are dealing with practical, non-linguistic skill (Pálsson, 1994). Another position is political and not very noticeable in Europe compared to North America. For this political position local knowledge appears to have absorbed the sacredness of native identity as well as that of property (copyright) that can be defended at court. In Europe the situation is different. It would seem that fishermen should consider themselves lucky if researchers and authorities do take an interest in what they know, since that might contribute to demonstrating the rationality of fishermen's actions. Whereas the situatedness of local knowledge has been the central point of some studies, others have chosen a pragmatic approach and collected local fishermen's knowledge with a view to comparison with and supplementation of biological findings (Fischer *et al.*, 1997). Such knowledge cannot be expected to live up to the requirements of data samples for general stock assessments. But as information on species or ecosystem characteristics it would be pertinent to management aiming at ecosystem maintenance rather than the fixing of output quantities (Wilson *et al.*, 1994).

Whereas anthropologists would mostly insist on the explanation of social phenomena relative to their context, and probably recommend management research to do the same, there is also an awareness of a disciplinary contradiction in this. The relativity of the particular stands in contradiction to comparison and to the study of humankind in general, which is also part of the anthropological research agenda. In the same way management research will need to understand fisheries in context as well as generalised and comparable, so the holistic study of fisheries is not simply the solution.

Reflexivity and research themes

Ethnographic fieldwork means that researchers must use their subjective persons as research instruments. This acute tension between the subjective and the objective has created an awareness in anthropology of the epistemological conditions of research. It has made a virtue of trying to transcend unreflected premises in one's own research and of spotting such premises in the research of others. Doing that is not very different from studying the world views of alien cultures. The deconstructivist critique of science as fundamentally dependent on its social and historical context ought not be news to anthropology. Even science is culture.

If science is culture, its truths must in some way depend on culture and cultural variation. This does not necessarily imply that research results must be either totally determined by or totally independent of institutional and other contextual circumstances, though in polemics the temptation is to argue the imprisonment of research and truth in context as an either / or. Relativist, particularist or contextualist positions are more common in so-called soft disciplines than in hard sciences because of the character of the research itself. But there is also an identifiable political interest in this position. It is an attack on the privileged access to influence held by the hard sciences. The objectivity of the hard sciences is important for their advisory functions in policy making. From a hard science point of view soft disciplines must be lacking in objectivity. For a relativist theory of science the reverse is also the case.

A bit of reflection on what the science institution is in a modern society would make it clear that epistemological relativism is not just a scientific or philosophical problem; it is an institutional problem that concerns what researchers are paid for. A modern democratic society has particular institutions designed to take care of the representation of interests relative to their weight. That is not the function of the science institution. It belongs to the type of institution that provides disinterested statements or disembedded decisions about truths, like iron ordeals or the poison oracle among the Azande of Sudan (Evans-Pritchard, 1937), statements that social systems need to have from outside of their interested dynamics. In the Azande case, you could not establish the truth value of a witchcraft accusation by asking those involved. An independent statement of fact was needed, before the judicial system could deal with the case. The institutional setting of researchers is similar, when they advise on matters that interested parties have opinions on. The truth question needs to be disinterested for the sake of the political system. Otherwise there will be a distortion of political representation. The institution can be changed, but as long as we have it, its demands cannot be changed, even when we realise that, despite honest attempts, context and interests do leave their imprint on science.

It is not a solution to the relativity problem or the deconstructivist critique to abolish the science institution. That would leave fisheries management and policy in a difficulty with regard to advice. As it is, a relatively limited number of people are paid to be disinterested researchers, and their pay is independent of the content of their results. Without the science institution advice and information would have to come from interested parties, who would then have their interests represented both before and in the political process, or who would have to be asked to act disinterestedly. So instead of small specialist groups trained in distanced viewing whole population segments would have to abstract from their interests.

Reflecting on our epistemological conditions gives us, more than anything else, reason to consciously try to identify the axioms and premises that we absorb from the trends and prejudice of our social context in order to transcend their unintended effect upon research.

Future research themes: the effect of values

The relativity and reflexivity perspectives will continue to affect the anthropological choice of research themes. Within that framework there is good reason still to research

the merits of existing institutions relative to the goals of fisheries management and in comparison with the home-made institutional designs of political or administrative authorities. The same goes for the study of local knowledge.

There is another holistic research theme that calls for attention. Often holism means little more than to remember the context, but in a more strictly Maussian sense it requires that the value dimension of social institutions be included. The value dimension of social institutions is crucial as a context of conflict and cooperation between industry and authorities. So, there are practical management related reasons to focus on values. In fact, values have been an issue for legitimacy oriented management research, but it has not been a prominent theme, and there are cultural as well as theoretical reasons for this.

Values and research

Within conventional modernisation theory the disappearance of values associated with traditional institutions would be seen as only a matter of time. This is what Berger and Piore (1980: p. 89) calls the 'withering away paradigm'. Modernisation, being a process of rationalisation, should mean that management related research would eventually have to deal only with rational values that could be theoretically accounted for. But modernisation theory missed something, and we seem still to be left with values as an underesearched and undertheorised domain.

Some types of value are intensely theorised in economics. They are what Western culture would see as rational or utilitarian values, but the cut-off point of theory is usually where value cannot be translated into measurable and comparable units (price) or into a constant (to win, power). Economic theory systematically theorises value, but not irrational value, religious value, invaluable value, types of value that can be important motivations for action. Such values are still social facts with a part to play in maintaining social order, internal peace, but they are not usually explained as part of a system theoretically accounted for. Instead they turn up as disturbing elements that explain exceptions or they are picked up as stones on the road to be used for *ad hoc* explanations.

The exceptional or peripheral place of moral value in management research is no more than the mirror image of Western cultural classification that associates rationality with economy and politics (i.e. public affairs) whereas irrationality is associated with religion (i.e. predominantly private). In this scheme quantifiable and utilitarian values assume a factual reality character, whereas other values do not. One of the reasons that research should include reflections on its own conditions is that it should help us not to be seduced by our cultural categories. It is a fallacy to confuse value free research with research that excludes moral values from the categories of fact you can study. If moral value is not part of theory, social order is left to be accounted for by utilitarian values alone, or not to be accounted for at all. The consequence for policy making is that maintenance of social order is left to the lay considerations of politicians and bureaucrats which is perhaps not so bad since their experience and wisdom may not suffer from the same theory generated blind spots.

Christian Lequesne (see below) suggests that French fisheries management should be understood as a contract between authorities that promises little intervention and a high degree of local self-management in return for social peace. Even if this is a utilitarian way of phrasing the relationship, it has the rare virtue of being preoccupied with social order as a problem that cannot just be reduced to an automatic effect of a good economy and sufficient welfare benefits. I am suggesting that the meaning and value of fishing to fishermen and society is an important future research topic in anthropology for the sake of management as well as for theory.

The producer is a loser

The meaning and value of fisheries to fishermen and society has for a long time been linked to a modern, in part even pre-modern, producer's perspective. This has changed as part of a remarkably systematic transformation that may have the emergence of a post-industrial labour market as its underlying cause. Being a producer was until recently a normal, useful and appreciated activity. Being fishermen had the preconditions of being particularly valuable, since it involved high level concerns like food provisions for society and the risk of life for fishermen.

The producer perspective has changed into a consumer perspective. When the normal member of society was a producer, society provided recognition in return. With consumers as the normal members of society, the roles are inverted; consumers provide their society with recognition for being a society that lives up to the rights of consumers. Producers, on the other hand, are liable to suspicion for dubious activities and intentions. Work or labour that used to be something to provide or sell as a burden or a duty has acquired new dimensions as a valuable good that can be enjoyed and consumed. In Denmark what used to be the Fisheries Ministry and Agricultural Ministry have become the Food Ministry, and the research tasks of the Fisheries Research Institute have changed correspondingly (Kjær Hassager, 1998). In short, there is a major transformation going on that removes the customary basis for the meaning and value of fisheries for fishermen and for society. What are the prospects for cooperative relations between industry and authorities, if the vacant slot for the industry in the social cosmology is a negative one?

Gaps across disciplines: knowledge or ways of knowing

Gaps in knowledge across a multi-disciplinary field of fisheries management research would change with the discipline one asks to identify the gaps. In many cases the problem is not gaps, but that other disciplines do not do things our way. And if in fact there are gaps other disciplines might help to fill, they might not fill them in a way useful to our discipline.

Each discipline cuts its field of study or subsystem out of the whole in its own way; it carries out research on its own epistemological, methodological and theoretical premises, often with a minimum of reflection, and it presents its findings primarily to audiences sharing the same assumptions and premises. Gaps are creations of theory more than anything else, and the big ones emerge when we remain in the relative isolation of our own school in our own discipline thinking that the others basically do what we do.

Table 4.1.1 shows just a selection of the parameters that differentiate theories of science and theories of the world. The columns are not internally coherent, though the two columns resemble a differentiation between hard and soft disciplines. Each research tradition represents a selection of positions out of these options, and it is an important precondition of multi-disciplinary, let alone inter-disciplinary, research to be aware of the premises involved.

The common property debate is a case where a lot of discussion has taken place on unclear assumptions. The 'tragedy of the commons' theory has most of its premises in column 1), with some exceptions. It is not really an empirical, inductive theory, it is a theory based on rational, *a priori* deductive logic (Brox, 1990). Even protagonists of the 'tragedy of the commons' theory are seen to argue as if the theory was an empirical generalisation, but it is not. Therefore it makes no sense to disprove it by empirical counter examples. Furthermore, multi-disciplinary collaboration on common property issues will be a waste of time, if the participants are unaware of the relationship between their own theoretical premises and that of common property theory.

Table 4.1.1. Intra- and inter-disciplinary parameters of difference

(1)	(2)
Universalism	Relativism
General	Particular
Comparative	Contextual
Empiricism	Rationalism
Induction (*a posteriori*)	Deduction (*a priori*)
Entities	Relations
Causality	Logic
Measures	Meaning
Function	Structure
Subjective actors	Objective systems
Continuous variation	(Hierarchical) segmentation
Equilibrium	Contradiction

Starting from common property theory as an *a priori* theory, the pertinent question is not whether the theory is empirically wrong but whether the premises apply in the case under study. We may then find that the actors' choices do not follow the premise of profit maximisation. The actors stick with fishing even though supplementary incomes from wives are necessary to stay in business. Can we account for such uneconomic behaviour by calling in another discipline? Possibly, but if the help asked for is requested on the basis of a methodical individualist position, where social order emerges from the interaction of actors, where relations are explained on the basis of entities, where values can only be accounted for if quantifiable or constant, how, then, will the answer be understood if it is based on a structuralist position which is in many respects the theoretically inverse? A fair guess would be that it would be received with some scepticism and possibly misunderstood. If the values that could explain uneconomic behaviour cannot be accounted for systematically within neoclassical analysis, what use is it then that another discipline with another theory can do it? If this other account could be reduced to the terms in which neoclassical theory can deal systematically with values, then it would be useful. Otherwise, it requires some

tolerance not simply to dismiss the explanations of other disciplines as equally unscientific as one's own would have been.

It does not all boil down to theory generated gaps between disciplines. There are gaps in empirical research that could be filled by multi-disciplinary research. In particular, there is a shortage of comparable, not to say comparative, studies of European fisheries and their conditions. Comparisons can be made on the basis of standardised data taken out of context. But holistic studies of fisheries, their institutions, technological traditions, social status etc. are generally not very comparable, because most of them are one of a kind that describes and analyses a particular case in context. An attempt to make a limited number of coordinated, comparable total location studies spread across Europe could help to generate new insights into differences that cannot be identified by comparisons of quantitative data (Vestergaard, 1997).

How to cooperate?

Disciplines need to be aware of the epistemological, methodological and theoretical premises of their own and other disciplines. Failing that, we cannot ask for the help of other disciplines, nor understand the answers we get. We cannot carry on from the assumption that everybody else is either sharing our premises or wrong. This is not just a problem that can be fixed by recommending researchers to be awake. It is not enough to be an excellent technician, if the techniques as taken for granted. Philosophy and theory of science cannot be left to the philosophers. All researchers need it to reach across to other disciplines.

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4.2 Fisheries social science - between management science and advocacy for the 'underdogs'?

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Introduction

First of all, thank you for the invitation, which in practice has meant spending several sleepless nights pondering over the present situation and the future of fisheries social science. For someone who has spent the last six years leading a fisheries college, this opportunity has been a case of 'retraining', trying to work myself back into research or at least the research agenda.

Secondly, the organisers of this workshop have not made it particularly simple for us, by insisting on a common framework. This is problematic, as current status, future research, existing gaps and the organisation of research are highly dependent on your personal point of departure. "Tell me where you sit and I shall tell you where you stand" is a popular saying by the former minister of education in Norway, the sociologist Gudmund Hernes. It goes without saying that my position, at a research and teaching institution, based in Europe's absolute periphery, is going to influence my approach.

Thirdly, social science within fisheries is a mixed undertaking. Its role, in Norway as well as in Europe, the US and Canada, has been as an advocate for the 'underdogs', the ones marginalised by the modernisation process, and the peoples and societies hit by administrative measures introduced by government authorities, be it in the name of fisheries biology or fisheries economics (Brox, 1990). On the other hand, when the social sciences have been called upon the last ten years, it has been in order to supply explanations why modern management interventions do not work, or deliver unexpected results, or simply to work out criteria for interventions in fisheries dependent societies and regions.

Some colleagues end up asking the rhetorical question: is it possible to be partly pregnant (?!) or phrased more academically: is it possible to deliver inputs to the fisheries administration and at the same time do critical research, often on behalf of the ones not being heard in the policy process. As will be evident from this paper, the answer is tentatively 'yes'. Fisheries social science cannot be satisfied by being a small isolated ghetto for 'the particularly interested', meeting occasionally to exchange views and papers, which hardly anybody reads, at least not the fisheries administrators. Fisheries social science has to participate also on the political side, presenting questions and results in a format suitable for the policy process. We do not, however, promise to deliver the 'right answers'. Sometimes, our values will be definitely different from those of the decision makers, be they on a supra-national, national or regional level. At other times, the results of our contributions will be to complicate matters, showing that management interventions are seldom as simple as

they seem, or by indicating alternative perspectives. As we all know, defining the problem is (at least) half way of finding the solution!

With these qualifying remarks, I shall stick to instructions, at least in broad terms. Since fisheries social science in Europe, or more precisely in the North Atlantic, has recently been presented in an annotated bibliography (Vestergaard *et al.*, 1998) I will stick to Norwegian experiences, hoping that the examples will prove to be of value also in the European context.

The rest of the paper is divided in four sections: first, a review of the current research situation (where do we stand?); second, a description of some major themes for the future research; and third, a contribution to the notion of filling the gaps in our knowledge of fisheries management. Last, but not least, I will try to offer some ideas on how successful research could be organised. Being originally a sociologist, I should hasten to add that my approach will not be limited to fisheries sociology, but include anthropology, political science, ethnography, geography as well as organisational theory.

From individual strategies to institutional constraints: a brief review of the Norwegian fisheries social science literature 1966-98

The following account is definitely a reconstruction, neglecting the often contradictory nature of scientific development, where 'new ideas' often turn out to be old, and where 'scientific progress' does not follow the time dimension. Nevertheless, besides Barth's (1966) and Brox's (1966) seminal works on actors' strategies, onboard and in marginal societies in the north, the more prolific writing about fisheries in social science, started with the establishment of the University of Tromsø in 1972 and in particular the Norwegian College of Fishery Science. The College (NCFS), originally an umbrella organisation for fisheries studies at the universities in Bergen, Trondheim and Tromsø, was established 75 years after the Agricultural University of Norway (NLH in 1897), thereby clearly indicating the marginal role of fisheries in higher education. The fishery was a latecomer, in spite of the pioneer role played by Norwegian marine science, starting with the important works of Sars, Sverdrup and Nansen.

NCFS was in the (un)lucky situation that hardly any literature existed, at least in Norwegian, within the field of fisheries social science. In order to improve the situation the pioneers wrote textbooks in Norwegian and more academic articles in scientific journals. Within ten years an impressive number of publications appeared, not only from Tromsø, but also from other academic institutions attracting more interest in the field of fisheries, that is, from universities and regional colleges as well as independent research institutions (see Hersoug *et al.*, 1993).

Studies by Barth (1966), Brox (1966) and Dahl Jacobsen (1965) created a host of follow-up academic work - some following the prophets closely and ending up by being more catholic than the pope himself! - others in opposition. The opportunities and constraints for the fisherman was the starting point. Why, for example, did some (especially on the West Coast) prefer trawlers and larger offshore vessels, and why did others (especially in the North) remain with smaller coastal vessels? Brox had

delivered his answer, which he extended and reiterated through an number of publications (Brox, 1984; 1996) ending up with the thesis that fisheries policy, organised from the top, had destroyed the opportunity situation for the small-scale, coastal fishermen, closing the commons and creating a 'guild' of quota owners.

Others, like Wadel (1973) tried to explain the expansion more in terms of fishermen's (and family based) strategies, where pooling of resources was critical together with fishing ability. Sciersted (1983) looked more closely into the labour market in fisheries dependent regions, finding that fishing was indeed an 'employer of last resort'. In boom times, with plenty of opportunities in the national labour market, fishermen would change occupation, while in bust periods the (male) coastal population would retreat into the fisheries. However, due to more strict entrance regulations, both in fisheries and in related occupations, changes were reduced over time, creating more unemployment among fishermen in the lean periods. Effects of educational reforms, keeping young boys longer in school, reinforced the recruitment problem which has remained a major research challenge to this day.

Jentoft (1981) and Jentoft and Wadel (1984) tried to expand the perspective, from dealing exclusively with the catching sector to encompassing the fishing community. They were showing the interconnectedness between fleet and factory, introducing the 'domino theory' applied to fisheries communities, implying that different policy measures (and individual strategies) had to be measured against the effects at community level.

Others, especially female researchers, were concerned about the exclusive perspective on men and the catching sector. Gerrard (1983; 1990) showed the importance of women as a base crew in the fishing industry, while Saugestad (1980) showed that in the farmer/fisherman combination, the farmer was most often a woman. Holtedahl (1986) described a society being modernised, by the women taking up new positions, with repercussions not only for the fishermen but also for the whole fishing community. Women were also predominant in the important processing industry, as shown in two early factory studies (Midré and Solberg, 1980). Later studies have shown how these arduous employment positions have gradually been replaced by short-term guest workers and 'imported' labour, first and foremost by Sri Lankan refugees and guest workers from neighbouring countries. Finally we have some illustrations of women's important but limited participation in fishing itself and especially in the factory fleet (see Munk Madsen, 1997) and as leaders in the processing industry (Husmo, 1998).

However, actors do not act alone. Very soon interest turned to the powerful organisations of the fishing sector, starting with Hallenstvedt and Dynna's (1976) description of the Norwegian Fishermen's Association. Later a number of important organisations were described in monographs (Christensen and Hallenstvedt, 1990), while Hallenstvedt (1982) gave the first coherent description of the whole organisational arena, covering not only the hundred or so organisations of the time but also their complicated relationship with each other and with the authorities.

The relationship between the fishing sector and the authorities had actually been described by Dahl Jacobsen as early as 1965, trying to portray the fisheries as a sector

without its own specialists, thereby vulnerable to influences from other ministries, like Trade, Foreign Affairs, and later Oil and Gas, Environment and, not least, Agriculture (which plays a central role in aquaculture). Holm (1995) has later developed the organisational perspective more in the direction of institutions, showing how the main institutions in the Norwegian fisheries changed in the 1980s, following the establishment of 200 mile exclusive economic zones. At that time, subsidies were declining in importance and the main attention was concentrated on resource allocation, through the Regulatory Council, where fishermen continue to exert the largest influence. Nevertheless, the Norwegian fishing sector is still heavily influenced by old institutions (like the Raw Fish Act) while other pieces of regulation were changed or nullified as a result of the liberalisation of policy (Holm, 1996).

Fisheries have also been considered in the light of regional policy and district policy (Hersoug and Leonhardsen, 1979), focusing on the relation between resources and local development. The tendency seems to be that the more national and the more sector oriented the policy, the less the possibilities for more marginal societies to survive, based on traditional resource utilisation (Jentoft, 1998). This is also the driving force behind the large volume of research on co-management regimes in Norway, starting off with Jentoft's (1989) now classic contribution. Later writers are all trying to provide a rationale for more local participation, in order to provide more legitimacy to the policy and reducing the costs of control and surveillance (Jentoft, 1994). This is also the argument behind the most recent critical assessment of national policy making, practised in a local setting (Jentoft, 1998; Sagdahl, 1998; Nilsen, 1998).

Other researchers have been more occupied with the larger setting, showing how the international regimes and conventions are influencing the development of the fisheries (Holm, 1993; Hoel, 1994). Liberalisation, increased trade in raw material, the fall of the former Soviet empire and the enormous overcapacity of the fishing fleets have within a few years transformed the entire fishing sector. The perspectives have also been transformed. While transaction analysis dominated the 1960s and 70s, we find today a multitude of disciplines and perspectives, where no one is able to claim hegemony. That is not to say that all are equally interesting.

New wine in old bottles or old wine in new bottles - major themes for future research

From my very brief exposition of Norwegian research within fisheries social science, there seems to be some evident gaps, or more precisely, a need for new research due to changing circumstances in and around the fishing industry.

First of all, the role of women is still 'under researched', not only as participant in the fishing and processing industries but more so as participants in the fishing communities. What happens when the women change priorities, select other occupations and educate themselves out of the fishing communities? What happens to the communities and the traditional ways of life? Will the exodus eventually provoke other types of fishing, e.g. in terms of regulated working hours, as in the oil industry, or will fishermen, as in some North Norwegian villages, start 'importing' women from Russia or Third World countries? We could also focus directly on the

repercussions in the catching sector, where factory trawlers seem to be able to 'solve' the problem, by bringing the women onboard and paying so generously that recruitment problems hardly exist.

As pointed out by Vestergaard *et al.* (1998) the downstream activities (processing, distribution and retailing) are poorly covered. The role and strategy of the large chains, now effectively controlling most of the daily household retail trade should be investigated and in particular their preferred strategy of letting certain peripheral producers be responsible for production under 'private labels'. Is it possible to survive as an exclusive 'niche' producer, or do we see a general trend, as in the food industry, in terms of ever larger processing units? Another important aspect of industrial strategy is the extent of vertical integration. What is the explanation for certain companies embracing this strategy, while others leave the catching operations entirely to the fishermen themselves (Dreyer, 1998). It is, however, necessary to engage also outside the relatively limited perimeters of the fishing industry and analyse the role of the agricultural industry, knowing that this industry is heavily subsidised all over the world and is actually the main competitor for most fish processing industries.

A third area of great importance is aquaculture, which in Norway this year will surpass the whitefish sector in economic importance. What is happening in industry in terms of its reorganisation, vertical integration, diversification (into other species) and regional significance (Aarset, 1997)? Can the aquaculture industry partly offset the effects of a steadily decreasing fishing industry? Can the traditional fishing industry copy some of the more successful elements from aquaculture (e.g. logistics) or do the two industries compete, in terms of markets, capital and qualified manpower?

Even if every industry is grappling with the consequences of 'globalisation', this is a theme of particular interest for the fishing industry. The industry has always been international on the production side (Norway is for example exporting 90% of its total production, that is, more than 2000 products to 160 countries), but liberalisation of the import/export of raw material has effectively contributed to a world market for raw fish over the last ten years. This has again led to different trade and production patterns and not least to a looser coupling between local fleet and local processors. The processors buy where it is cheapest and the fishermen sell where they obtain the best price. The effects remain to be documented - not least in terms of the fishery development communities/areas (Arbo and Hersoug, 1997). Of particular interest is the 'new regime' being developed in the North Atlantic, where fish, in terms of quotas, are being traded, not only among different fishing nations but also among different operators, often participating in complicated networks, containing several nationalities operating in a relatively footloose fashion in relation to the resource owners. Even more interesting is the organisation of the fishery outside the 200 miles EEZ, where new alliances are turning up every week (Hoel, 1998).

A completely neglected area in our Europe-centred approach is the artisanal fisheries of the Third World. As we know, they account for most of the fishermen in the world and more than half the catches for human consumption. A possible link to the European fisheries could be the investigation of the effects of EU fisheries agreements in Africa, Latin America and the Pacific. This is a rather controversial theme in most

developing countries and more facts about the effects and consequences are urgently needed.

A final 'gap' is the distributional effects of existing fisheries policy. Through bio-economics and particular economic investigations (*budsjettnemda*) we know much about the economic effects on a fleet level. However, on the individual or community level, we have few facts and hardly any good models at all. Fisheries biologists and economists alike have for several years urged the social scientists to engage in the (tedious) work of documenting distributional effects of a particular resource allocation. So far, social scientists have been eager to document negative effects, normally within a rather limited area, but have little to offer in terms of input when distributional questions are up for discussion.

In more general terms this is translating into a more complex question of what is meant by 'social sustainability'. Biological and economic sustainability have so far been given at least a workable definition (see e.g. Garcia, 1996). Knowing that fishing communities always have been changing, adapting to changing natural conditions as well as market situations, what is the bottom line for social sustainability? The next question is even more complicated: to what extent can social sustainability be achieved through management means within the fisheries policy?

The missing link

As indicated in the title of the paper the underlying model is rather simple:

more knowledge through research ⇒ *improved management* ⇒ *better results (for fishermen, processing industry and fishing communities)*

We know that in reality it is not that simple. Improved knowledge does not necessarily result in better management. A number of biologists (*cum* administrators) acknowledge that management through Total Allowable Catches (TACs) is a means with severe deficiencies (see Holden, 1994). The TAC regime is however predominant in the EU, Norway/Russia as well as in most other important fishing nations, mainly for political reasons. Only through TACs can shared resources be divided. A country like Norway, where 80% of the total catches is based on shared resources, can hardly change to 'adaptive management' without serious repercussions concerning its 'natural' state of the common resources.

The same applies even to exclusive coastal resources. Through DNA based research we know today that North Atlantic cod is genetically different from coastal cod (or more precisely, from a number of genetically different coastal cod stocks (Holm *et al.*, 1998)). Nevertheless, this new knowledge is not going to produce any improved management, at least not in the short term. Nobody in the fisheries administration would like to see a change that would upset not only the international division of resources but the national distribution keys as well.

Even in a situation where we actually obtain improved management, this will not necessarily result in improved results for the fishermen at large. All results obtained by 'better management' seem to carry some side effects, which are normally not

compensated. The example of rebuilding the stock of Norwegian spring spawning herring is a good case in point. From a management point of view the rebuilding of this stock has been a resounding success. However, for most North Norwegian fishermen it has meant reduced capelin fisheries and, at periodic intervals, severely reduced cod and shrimp fisheries.

The same applies to the newly accomplished fisheries agreement with Iceland in the Loophole. The nation gained while the cod dependent North Norwegian fishermen lost even more of their scarce quotas to the Icelandic trawlers. The point is not to dispute the idea of 'better management', but only to indicate that results are most often unevenly distributed, not only among fishermen, but between fleet and processing companies and between different fishing communities. For precisely these reasons it is hard to obtain any unanimous consent about what is considered 'improved management' (improved for whom?). Multi-species management will in this respect probably only contribute to more disagreement over resource distribution.

The role of science in fisheries management

Biological science (stock assessment) is still the central element of all fisheries management, instituted in generally accepted organisations like ICES. Economics is playing an increasing part through national strategies, being employed after ACFM has delivered its recommendations. The biological advice, tempered by economic considerations, is then being balanced with a host of 'political necessities', where little is substantiated by social research and more is presented by way of effective lobbying on behalf of powerful interests.

Wherever we turn in fisheries management, the role of science is crucial. Most actors try to clothe their arguments in scientific garments and the occasional refutation of scientific arguments is hardly taken seriously. Naturally, there are a number of fishermen who claim to have better knowledge of fish, stocks and the resource situations than the scientists. But in the end even the fishermen's arguments are strongly influenced by scientific language and models - not surprising after 50 years of 'indoctrination' by the national marine institute at every regional and national meeting of any importance.

From a social science point of view even the natural (sic!) science biology is socially constructed, that is, categories as well as models are chosen, not given in nature. The heavy impact of biologists on fisheries management must therefore by explained in terms of institutions and power. In our case it is of great interest to investigate the role of scientific schools or models, scientific organisations like ICES, science in the fisheries administration and fisheries politics and finally the role of science as legitimating power within the industry. My intention is not to subvert the role of biological science which is, and has to be, central in any type of fisheries management. The message is simple: the present model is too simple! We should not be constructing a pyramid of fisheries management where biology is the base, economics the middle layer and social science the apex. Instead, we are all participating in an experiment of trial and error, where science, political forces and industrial groups are cooperating and competing, offering results which at present are not very satisfactory.

How to organise?

Most fisheries' problems or challenges require a multi-disciplinary approach. Nevertheless, most fisheries research is uni-disciplinary, or even more specialised, using only a few of the many possible theoretical approaches possible. At NCFS we have tried for more than 25 years to organise both multi-disciplinary and inter-disciplinary research. Our first important lesson, if you want more research within fisheries related problems, is therefore to reorganise old institutions or to create new ones! (This is also the policy behind the relocation of the Norwegian Polar Institute, which had to move from Oslo to Tromsø and thereby could reorganise most of their research, establishing new areas and new groups, bringing in completely new researchers as well).

Our second lesson is that multi-disciplinary approaches can be organised while inter-disciplinary work is hard to get off from the ground. Bio-economics is one of the very few fields where you can see two professions working together, creating a new field of science. The reasons why this has not been a success are many, but of paramount significance is the fact that the whole incentive system at most universities is closely connected to the specialised disciplines; you advance by publishing in the most important disciplinary journals. Engaging in multi-disciplinary projects is risky for younger researchers, while few of the elders have the guts and the patience necessary to get such projects organised and implemented. Besides, scientific boards are not very fond of inter- or multi-disciplinary research either. In short, the basic framework is not geared towards multi- or inter-disciplinary efforts. What can be done in order to overcome the difficulties?

One answer is to organise multi-disciplinary education. After having produced a Masters' degree in fisheries for 25 years we start to get some graduates who seem to look differently at things. Another, less costly approach is to construct networks, like ESSFiN, which brings different researchers together for longer or shorter periods, thereby facilitating the exchange of information. A third possibility is to create multi-disciplinary research programmes as we have done recently in Norway, by setting up a relatively large programme on fishery related research in developing countries. Again, researchers from different backgrounds are brought together, even if they do not cooperate on the same projects.

All in all, there are some promising possibilities, like the opening of arenas which previously have been occupied exclusively by the specialists. One case in point is the biannual IIFET-conference, originally based on economics only, where now a number of social scientists from other disciplines participate and deliver papers. Another example is the common property network, where everybody concerned with the challenge is welcome.

Finally, a minor but important reservation: providing better research is only one of several important factors affecting the outcomes in fisheries management. To rephrase an old slogan: 'research counts but resources decide!' In other words, power and politics are still the most influential factors shaping the fisheries policy. The 'new' approach is that even science can and should be seen as part of that power play.

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4.3 Studying European fisheries from a political science perspective: a research agenda

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Introduction

For a political scientist whose first interest is the study of the EU as a polity, fisheries constitute an excellent case study for understanding more deeply how policies and politics are made in Europe beyond the nation state. Since 1997, my research has focused on why a Common Fishery Policy (CFP) has been put on the EU agenda and how it is implemented in the member states. Through the study of fisheries, I would like to see how the EU has become a necessary dimension of political action for states and administrations, but also for a variety of social actors (not only fishermen but also final processors, fishmongers, environmentalists, scientists, etc.).

Before starting regular interviews in France, Spain, and the United Kingdom for a book to be published in 2000, I have tried to check to what extent a political science literature on the CFP exists. The material at my disposal looks quite weak (Shackleton, 1986; Thom, 1993; Gray, 1998). I have found rather more economic and legal studies on CFP than political science studies. Of course, the borders between disciplines are not 'watertight' and a legitimate question could be: what does political science literature on fisheries mean? A simple answer to that question would be: the literature which studies the way power is exercised and contested in the EU fisheries sector.

In this short paper, built as a research agenda, I will stress six questions raised by the study of CFP which can invite political scientists - especially younger ones - to investigate the EU fisheries more deeply.

The 'politicisation' of fisheries in the EU

According to the predictions of neofunctionalist theorists (like Haas or Lindberg) in the 1960s and 1970s, the EU should progress through the action of rational experts reaching compromises on a new common good in a depoliticised manner. If these predictions were right, fisheries should have been the domain '*par excellence*' where experts build a transnational policy on rational interests like fighting overfishing, coping with the future of ecosystems, etc.. The reality has been very different.

Fisheries in the EU is still a question of 'high politics' in which non-rational arguments do confront rational interests and where politicians have not delegated all their power to experts. Moreover, there is an interesting gap between the modest contribution of fisheries to the national economy in most EU countries (less than 1% of GNP, even in Spain) and the sophisticated institutionalisation of the political agenda (both European and national). This 'politicisation' of fishery has to be studied beyond statistics and positivist evidence.

(i) Politicisation means looking at the mobilisation of actors *vis-à-vis* formal institutions which has not to do only with rational interests but also with social representations built through historical processes. Analysing the decisions of EU governments, the positions of the fishermen, the support of the various societal segments, etc. means taking into account the historical relationships, in different national contexts, between the sea and the building of national sovereignty, the images/clichés that national societies have for the contribution of fishermen to the national welfare, etc..

To take a concrete example: the politicisation of 'quota hopping' in the UK is not only linked to the economic disadvantages it represents for British coastal regions. It has also to do with the symbolism of the 'Union Jack', with the challenge it represents to a conception of state sovereignty. Those elements explain for instance why 'eurosceptic' political movements in the UK have instrumentalised 'quota hopping' during the electoral campaign of 1997 and the negotiation of the Amsterdam treaty.

(ii) To understand the politicisation of fisheries, we have also to take into account the concentration of a high degree of dependence on this single activity in micro-territories like Western Galicia, Southern Brittany, the Scottish Islands, etc.. Political scientists have to study more carefully the ways in which industry, local politicians and local societies interact on the fisheries issue in these micro-territories, especially when a situation of economic/social crisis occurs. Did, for instance, a majority of the society in the French Pays Bigouden support the '*comité de survie*' in 1993-1994? If so, on which grounds?

Concerning local politics, we know very little about the way fishermen are supported by (and, in turn, support) political parties. Does it make sense to speak of a 'fishermen's vote' in Cornwall, Galicia or Scotland? Because of their encroachment in local territories, are fishermen supporters of the regionalisation of polities in a number of territories, i.e. encouraging devolution and the SNP in Scotland, independence and Herri-Batasuna in the Spanish Basque country? These questions are sometimes important for understanding the positions of fishermen *vis-à-vis* the CFP. Having worked on the action of the Basque liners against drift nets in the province of San Sebastian, I realise that the main industry leaders against the technique used by the French, the Cornish and the Irish fleets were very close to the Basque party Herri-Batasuna. In their discourse in defence of their traditional gears for fishing albacore, we can find elements of a Basque nationalist ideology on protecting local roots against outside modernity, on protecting the 'small' against the 'imperialism' of the 'big' (in this case, foreign vessels). Even if the main issue of the conflict was very rational - protecting the price of fresh albacore on the Spanish market against imports - those ideological elements have also to be taken into account in order to understand the Basque liners' actions.

The relationship between scientific expertise and politics

As in many other fields - agriculture, environment or health - scientists produce considerable expertise and discourse in the EU on how to manage fisheries in a rational manner. What is interesting for a political scientist is not the scientific production itself but the way in which it interacts with political decisions.

(i) Do politicians (commissioners, ministers, etc.) have an interest in 'instrumentalising' scientific evidence *vis-à-vis* the fishermen? Do they really take into account what scientists - and fishery biologists in particular - advise concerning stocks, TACs and quotas, technical measures, etc?

(ii) Why do most of scientists working on fisheries consider that part of their job is to help the political decision makers in their managerial tasks? A world 'epistemic community' of fishery biologists (IFREMER, CEFAS, ICE, ...) sharing a common paradigm on the necessity and means to protect fish stocks exists. Political scientists should understand where and how these biologists are being 'socialised' to a common paradigm (ICES meetings, scientific conferences). In the EU context, have they developed institutional strategies to become influential in the decision making process (positions within DG XIV, participation in the Commission's STFC)?

It is also interesting to study how the influence of biologists in the decision making process has been challenged in recent years by other sciences, especially the social sciences? There is a 'competition' at the EU level for the production of legitimate expertise. The 'politics' of fisheries economists to become more involved in the EU decision making process (through the creation of EAFE and pressures to enlarge the Commission's STFC) needs to be studied. Have these pressures pushed the Commission to concentrate its proposals on questions other than the conservation of resources - in areas of investments, market organisation, trade, for example?

Interest representation at the EU and Member State levels

Like agriculture, fisheries is not an homogeneous sector. Professional practices, profitability, openness to foreign markets, etc. are very different from one sector to another. This heterogeneity has institutional consequences for the way interests are represented both at the national and EU levels.

(i) *National level*: the heterogeneity of interests means a relative sectorisation of representation among industry organisations according to functional differences (long distance/deep sea fleet v inshore fleet in Spain or in France) or territorial differences (like in the UK with NFFO and SFF). For political scientists, a relevant question is: have fishermen's organisations the capability to influence national governments, societies, and EU institutions? Do ministers and administrations consult and listen to the industry (including professions other than the fishermen like fishmongers and food processors) during the policy process? Can we find different patterns of influence according to different 'national' policy styles which are more or less pluralistic or corporatist? This means studying fisheries not as an isolated phenomenon but as part of broader national policy making. For instance, the role of the 'CNPM' in France or of the 'Produktschap Vis' in the Netherlands has to be analysed in connection to the corpororatist policy styles of both countries. Do the different patterns of relationships between the fishermen and the administrations have an impact on the enforcement of the CFP at the national level?

More generally, we have to think about how little time fishermen have - because of the nature of their job - for lobbying governmental institutions. Does this encourage the power of 'professionals of representation' among organisations? Does it give a

special role to women in interest representation? In France, for instance, the 'Fishery Act' of November 1997 allows fishermen's wives to represent their husbands on consultative bodies. This delegation does not exist in any other sector (even in agriculture) and needs to be studied. If we take the conflicts in Southern Brittany in 1993-1994, fishermen's wives also exercised a leading political role in organising and structuring the political mobilisation of the '*comité de survie*'.

(ii) *EU level*: There are plenty of studies on lobbying and interest representation at the EU level (Mazey and Richardson, 1999; Greenwood and Aspinwall, 1998). Most of those books say nothing about fisheries. Several questions are nevertheless interesting for the political scientist:

* What is 'Europêche' really able to do? Does it get sufficient resources to represent the interests of fishermen at the EU level? Portuguese and Finnish organisations are not members because the fees are too high. Does the enlargement of both the EU Member States and the EU agenda make the possibility of reaching common positions within 'Europêche' more difficult?

* Consultation of industry by the Commission: there is the Advisory Committee for Fisheries which is in the process of reform involving fewer fishermen's representatives and the inclusion of environmentalist and developmentalist NGOs. Has the Advisory Committee been able to influence the Commission on the main CFP issues? Are DG XIV's officials controlling expertise in 'splendid isolation'? The way the Commission is preparing the 2002 reform is of great interest for political scientists. The 1998 questionnaire contains, for instance, questions on certain problems (market organisation, agreements with third countries ...) which are not under review according to the 1992 ruling. This is an excellent case study for analysing how the Commission is able to influence the EU agenda through its expertise.

* The European Parliament: fisheries matters are decided under Article 43 which only requires consultation with the EP. How then does the EP influence policy making on fisheries? Is the Fisheries Committee set up in 1994 a powerful one? Is it a source of alternative expertise to DG XIV through its reports, hearings, etc? How does the industry lobby this deterritorialised Parliament? Connections between fishermen's interests and MEPs exist in the EP. For instance, Fraga Estevez' report of September 1997 on the 2002 reform contains elements (on access) which are very close to what the Galician fishermen's organisations proposed. Gallagher's report of February 1999, asking for an expansion of territorial seas to 24 miles and a regionalisation of the CFP, is also close to what the Irish Fishermen's Organisation suggested.

* We should also investigate more deeply how the green NGOs - Greenpeace, WWF, Animal Welfare which have opened an European office in Brussels - use the EP to promote their values of 'sustainable development', 'precautionary principle', etc.. Is the creation inside the EP of intergroups - like the Intergroup on Animal Welfare which takes a strong position against drift nets - a way for those NGOs to influence policy making?

- We should not forget the role judicial law plays in the EU. How does the ECJ/TFI's jurisprudence influence the CFP (e.g. the Kramer and Factortame cases)? Is it easy for fishermen to use the EU legal procedures when they consider their interests to be at stake? For instance, fishermen of the Ile d'Yeu have asked the ECJ to nullify the Council's decision of June 1998 on the drift nets ban. How can they meet the solicitors' very high costs? Is the ECJ a promoter of market rules against a territorialised policy like the CFP?

The logic of the single market *versus* the CFP

If we consider the system of TACs and quotas, the principle of relative stability, the rules on the territorial seas, the impression is that the CFP is a territorial policy or at least a compromise between territories. You have then a contradiction between this territorial policy and the project of the common - or single - market which has been the core element of the European construct since 1957. This contradiction should be a rich source of study for political science.

An illustration of this contradiction is the problem of 'quota hopping'. With regard to the EU philosophy on the free movement of capital or persons, 'quota hopping' is a simple manifestation of the single market in action. But it is not perceived in this way in the countries concerned, like France and the UK. Fishermen's organisations are reacting against this practice; governments (even neoliberal ones, like the Thatcher administration) try to establish protective laws against 'quota hopping'. Why? Who are the Spanish and Dutch 'quota hoppers'? Do they represent a new type of fishermen which considers fishing activity more in terms of profitability for their enterprises and markets than in terms of territorial loyalty? How do they use the EC legal procedures to develop their activities against restrictive territorial laws (e.g. the Factortame case)?

The CFP and EU redistributive policy making?

In some countries like France or Spain, the state subsidises the fishery sector quite extensively, unlike the UK or the Netherlands where state aids are either low or non-existent. At the EU level, all countries share, according to their economic wealth, the 'Community cake' through access to the Structural Funds (Agenda 2000, IFOP, PESCA programme). For a political scientist, it is interesting to study how these funds are used and implemented in local territories. For the fishermen and for national governments, are EU funds considered as a *quid pro quo* for accepting reform in the fishery sector (especially fleet reductions through MAGP)? How do policy networks of fishermen, local politicians, local MEPs emerge at the local level (e.g. in Scotland, Andalusia, Brittany) to defend the eligibility of fishing activities for funding? Do EU funds have a real impact on the activity in these territories (e.g. the support of inshore fishermen, the building of infrastructures)?

Structural funds raise the question of which policy model the Commission and the Member State governments want for the future of fisheries? Is it a policy to support some traditional fishing activities with redistributive programmes (the 'identitarian' option)? Is it a policy focused on more equivalence between resource and market rules with some transitory support to social costs (the liberal option)? Or is it to have both

an efficient/market driven fleet and the survival of some traditional activities (the syncretic option)?

Fisheries and globalisation

For a political scientist, the international trade in fishing products is an interesting topic. The political mobilisation around imports of fish products into the EU have to be analysed through the relations between producers (fishermen) and traders (food processors). This raises several questions. How is free trade perceived by fishermen (demonstrations in Brittany in 1993-94 were initiated by cheap imports of white fish from Russia and Poland)? Is the EU trade policy an efficient protection against unfair practices (e.g. the antidumping clause against Norwegian salmon in 1998)?

The question of access to the waters of third countries through the EU external agreements should also be studied. It raises questions of overfishing, social dumping (cheaper labour force) and indirect distributive effects of the EU budget (supports for the creation of joint ventures in Argentina for example). We also need to study how some third countries (like Morocco) negotiate the modernisation of their fishing systems through EU funds with only a limited access given to EU vessels in their waters. What are the aims of the Moroccan industry and government?

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4.4 A Canadian conservation organisation's perspective on research in fisheries management

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Introduction

The Ecology Action Centre (EAC) is a citizen's advocacy group. The Marine Issues Committee (MIC), as part of EAC, focuses on how government policy affects coastal communities as well as ocean habitat. Our Marine Issues Committee has about 35 members that include scientists, students, professors, fishermen and professional environmentalists. We analyse how government policy affects coastal communities as well as ocean habitat. Our general approach is to research the policy which governs an activity and, if we find it deficient or ignored, we use that as a basis for our critique. Our motivation is not only how human activities on the ocean affect natural habitat but also how these issues affect local livelihoods and the health of coastal communities. In this paper, we describe some of our recent interests and our suggestions for future research agendas on fisheries management. Our interests include:

* Quota management
* Habitat and species diversity
* Ecological effects of new fisheries
* Marine protected areas
* Oil and gas development

Two common themes related to fisheries policy unite the issues discussed. First, conservation based solutions to various fishery related problems have been proposed for a long time but decision makers have lacked the political will to implement some of these conservative approaches. It is always next to impossible to make large scale changes; therefore we advocate experiments, or pilot projects on a small geographical scale, designed to test alternative fishery management methods. Second, many of our policies include conservation principles but we rarely see those principles applied. In many cases, policies in practice override conservation based policies. This is partly because we, as a society, have few conservation goals defined *adequately*, and little knowledge of how to use conservation concepts in practice. Can we define adequately such concepts as 'precautionary approach', 'ecosystem management', and 'ecological integrity' in the context of sustainability? We recommend a review of the inconsistencies among the governing and conservation based policies, and an analysis of how conservation principles can be applied.

Quota management

Privatisation

In Canada, the Department of Fisheries and Oceans (DFO) is the government agency responsible for the conservation and protection of fish habitat and for managing the fishery. Most major fisheries are regulated by a quota management system in which the government allocates a Total Allowable Catch to various gear sectors. Over the last decade, the government has allowed or encouraged a programme of Individual Transferable Quotas (ITQs) in the mobile gear sector to effect capacity reduction. More recently, ITQs have been touted as a way to reduce capacity in parts of the small scale, locally owned and operated fixed gear sector.

In most fisheries, we feel that quota management does not lead to long-term benefits for the environment nor for coastal communities, largely because of its inherent anti-conservation principles. Primarily, a quota management system leads to dumping, high grading and discarding. To compound the problem, the DFO's suggestion to reduce capacity was that the number of fishermen in each gear sector would have to be reduced by 50%. While the government should be lauded for trying to treat each gear sector equally, the actual fishing capacity in each sector varies enormously relative to the number of people employed. That is, the amount of fish caught per capita in the dragger sector far exceeds the amount of fish caught per capita in the fixed gear sector.

The fixed gear sector adamantly refused to accept an ITQ system when the idea was introduced in the mid-1990s. Through arduous negotiations, a fixed gear alliance was able to obtain a not wholly satisfactory alternative to the ITQ system. This alternative is known as 'community quotas', whereby the quota is allocated not to individuals, but to a community of fishermen in a geographic area based on their catch history. 'Community' in this sense is defined by geography and gear sector. The success of the community quota system (to ensure longevity of the coastal community and the fishery) varies throughout the province.

In response to the rapidly changing fishery, a group of academics, fishermen associations and conservation groups held a symposium called *Fisheries That Work: New Directions in the North Atlantic*. An EAC member was a co-editor of the proceedings (Loucks *et al.*, 1998). Various case studies were presented including some from community quota groups that had established guidelines based on conservation and fisher equity. It was agreed that various fishing groups were working positively towards protecting their resource, environment and the health of their communities. The final chapter of the proceedings outlines criteria for success as related to policy development including self-regulation by fishers.

Unfortunately, while some community quota groups are testing methods to conserve the stock and to ensure distributional equity, the DFO government policy has not kept pace and indeed undermines the spirit of coastal communities. The Fisheries Act controls and regulates the fishery. There have been proposed various amendments in Bill C-62. These amendments include the ability of the minister to form (private) contracts (partnerships) with fishery interests. While there is nothing that states that

community groups cannot enter into contract negotiations, there is no clause within the proposed amendment to protect the interests of local communities. It is feared that the more powerful fish processing sector will wrest control of the fishery through these private contracts, and it is believed that that sector will not have in mind the best interests of the environment nor the local communities. The most recent development has been that a government commissioned study of partnerships called on DFO to slow down and evaluate carefully the social impact of the proposed changes.

Suggested research directions

We suggest that future research agendas in fisheries management review fisheries policy as it relates to safeguarding the health of the environment and coastal communities. Some of the current policies contravene the spirit of conservation and of sustainable communities. Currently, community based management is occurring in a legislative vacuum; we recommend that research include the drafting of legislative amendments that would support conservation initiatives through community based management.

The introduction of the community quota system has allowed the evolution of a variety of community based management approaches. It would be useful to monitor these groups and evaluate which approaches are more sustainable and lead to greater conservation.

Dumping and discarding

Dumping and discarding exists in all gear sectors (but some gears involve proportionately higher amounts than others). There is very little data because this is an illegal activity. In response to calls from concerned fishermen on excessive amounts of dumping in the groundfish fishery, an EAC member conducted interviews of fishermen to find out more. She estimated that it was possible that up to one million pounds of mostly cod were discarded on Georges Bank in 1998. Although her estimate was based on anecdotal evidence, it raised the issue of continued and obviously damaging dumping in the groundfishery (Breeze, 1998).

The majority of interviewees conceded that the quota managed fishery led directly to dumping. As a solution to excessive dumping, fishermen's suggestions included mixed species quota allocations, stricter enforcement, and an effort based regulatory system (regulation of days at sea, limited fishing seasons, and a reduction in gear capacity). A transferable quota system leads to concentration of ownership but not necessarily to a reduction in the amount of dumping. Breeze (1998) wrote that captains and crew members were told to dump by their boat owners. EAC members are currently working with fishing associations to experiment with the use of effort as a control.

Suggested research directions

Is an effort based regulatory system a viable alternative to quota management? It would be useful to establish empirically the relationship between catch and effort and stock size. Presumably the catch rate or catch per unit effort (CPUE) would decline at

some point. How does this relate to stock conservation and can we set a target effort level that would protect the stock?

The catch rate varies among gear sectors. There is some evidence in the fixed gear sector that when the catch rate falls, boats will stop fishing because the cost of fishing exceeds the value of the catch. Does this lead to conservation of the stock? Given other conservation controls, can a fixed gear sector be self-regulatory?

Habitat and species diversity

Bycatch

Bycatch (the incidental capture of non-target species) is an extensive problem in the fishery. Much of the impact of catching non-target species is not documented. A myriad of species has been affected but because we have little baseline data on non-commercial species, we cannot assess the extent of the problem. We are working on several bycatch issues but in a somewhat piecemeal fashion. EAC members assessed the status of deep sea corals on the Scotian Shelf through a series of interviews with fishermen (Breeze *et al.*, 1997). The interviews suggested that dragging had destroyed much of the deep sea coral.

Another issue is that of bycatch in the swordfish fishery. A group of swordfish harpooners joined forces with EAC to publicise the extent of bycatch (e.g. sharks, tuna, sea turtles) in the swordfish longlining sector. The issue is complicated, as swordfish is a transboundary, trans-Atlantic stock. We have been making attempts to work with international conservation groups.

Suggested research directions

Although it is ineffective to work on bycatch issues on a species by species basis, we have little choice. The report on deep sea corals was generously received and is still in demand in both North America and Europe. It was an excellent example of how a non-governmental organisation (NGO) can use publicly available funds to bring to light important habitat and species issues, but it did make us think about the limited efficacy of a single species approach to conservation.

We advocate the establishment of a monitoring programme of the ecosystem including non-commercial species. The knowledge gained from the monitoring programme could be used to develop appropriate conservation measures to minimise bycatch.

There is some information on non-commercial groundfish species available from research vessel surveys. Both the US and Canada conduct annual bottom trawl research vessel surveys to assess the status of commercial species. These databases also include information on non-target groundfish species. We recommend that these databases be used, in conjunction with interviews with the fishing industry, to examine long-term trends in non-commercial species.

Species diversity and assemblages: The US and Canadian research vessel survey databases could also be examined to determine temporal and spatial changes in species diversity and assemblages. Specifically, what are the long-term trends in predator:prey ratios, generalist:specialist ratios and status of vulnerable species?

Habitat

Part of our work is the development of marine conservation initiatives regarding the sea floor through education, natural and social science. Our position is that benthic habitat can be irreparably damaged by destructive fishing gear. Section 35 of the Canadian Fisheries Act states that fish habitat cannot be altered or damaged without permission of the Minister. This section acts as a trigger for an Environmental Impact Assessment. Interestingly, the Act has never been applied to offshore fishing technology. Why not?

Fishing technology is a politically sensitive topic yet we need discussion and debate on this issue. As a first step, two of our members conducted interviews with fishermen to find out their perspectives on the seabed, how it had changed and why (Fuller and Cameron, 1998). Generally, the fishermen interviewed felt that fishing gear was damaging benthic habitat. The damage included removing epifaunal species, flattening hills and changing the substrate. The majority of those interviewed recommended that less damaging fishing gear be used. The recommendations of the authors stated that habitat protection be included as part of any management strategy, and that management strategies should be reviewed thoroughly to assess whether they have any indirect negative effects on habitat.

We recognise that damage to benthic habitat is a function of intensity as well as gear type. But we also believe that the least destructive gear type should be used. We are currently working on whether it would be possible to identify sensitive areas and then to recommend that those areas be fished with the least destructive gear. A constraint is that the majority of fishermen queried did not want to reveal exact locations of sensitive habitat because they thought the information would be used to restrict their fishing (Fuller and Cameron, 1998). However, the largest constraint is that discussion of ecologically appropriate fishing technology raises issues of quota allocation among competing gear sectors. Since the government does not want to be seen favouring one technology over another, and because the mobile gear sector is politically powerful, very little progress has been made.

Suggested research directions

While we advocate more research on the impact of dragging on habitat, we feel it is time to identify sensitive areas and allow only non-destructive gear to fish in those areas. To that end, we need research on how to rank habitat in terms of 'sensitivity' to fishing gear.

In Canada, the use of dragging technology is expanding into deeper water. We are opposed to this because of the nature of deep water habitat. Deep water habitat is less dynamic and less disturbed than shallow water habitat. It follows that the reproductive rates of deep water species might be more vulnerable to destructive fishing gear.

Minimally, we could establish baseline studies to monitor changes in deep water habitat.

Most of the research addressing gear impact on bottom habitat does so on small geographic scales. If dragger gear changes the bottom habitat, then might we expect habitats to become more uniform on a regional scale? Is dragging technology leading to a homogenisation of habitat? This can only be answered by researching changes in habitat, including topography, on a regional scale.

Ecological effect of new fisheries

Because of the decline in the traditional groundfish stocks, there has been an increase in the number of applications to fish hitherto unfished species. The Canadian government is developing an Emerging Fisheries Policy which includes such laudable principles as the precautionary approach. Unfortunately, at the same time, the Developing Species Advisory Board reviews applications mainly on an economic basis. That is, the main criteria for opening up a new fishery is whether or not economic gains can be realised. The secondary criteria do include possible ecological effects but our main concern is that we do not know the ecological effects of fishing down the food chain. The theoretical predictions include a change in trophic structure whereby large predators are eliminated. This prediction has obvious implications for the health of our oceans.

In 1997-98, a proposal to fish krill was submitted to the Developing Species Advisory Board. As krill are a basic component of the food chain and food for formerly abundant groundfish stocks, fishing and environmental organisations were alarmed. They joined forces to form an alliance and asked the Fisheries Minister to reject the proposal and further to withhold licences for fishing currently unfished species until a comprehensive Forage Fisheries Policy was in place. The minister conceded, and has called for a series of regional workshops to further the development of a policy on forage fisheries.

As a conservation group, we would prefer that none of the species occupying a central position of the food chain be fished. We realise, however, that this is an extreme position in light of the recent economic downturn in the groundfish fishery. We are currently researching science based rules that would govern decision making regarding what species can be fished where and how.

Suggested research directions

Various fishery associations advocate a 'how, where and when fishery' as an alternative to quota management. Guidelines for such a system include the use of the least destructive gear technology, no fishing during spawning season, no fishing on source populations and habitat protection. We would like to research how these principles could be applied to new fisheries, in conjunction with a monitoring programme to evaluate conservation objectives.

Research on food webs: can we determine central components of the food web? We, as a conservation group, would use the precautionary approach in practice and decide that central components of the food web should not be fished.

Marine protected areas

Along with other conservation organisations, we have been promoting a 'systems plan' approach to the establishment of marine protected areas (MPAs). Such an approach would mean that MPAs are viewed as part of an integrated conservation based management plan, and be established in ecologically representative areas. The Canadian government has recently proclaimed an Oceans Act (1997), designed to address the concept of integrated management. There is a provision within the Oceans Act that allows the minister to establish MPAs.

The first area to be nominated is known as the Sable Gully. Throughout 1997-98, members of the EAC were part of the process to establish an MPA in the Sable Gully. The fish processing sector and the oil and gas sectors were opposed to the establishment of an MPA. One of their reasons was that there was no overall plan indicating how many MPAs would eventually be established. Their fear was that there would be no limit on the number and size of MPAs. While we would like to see areas protected we can appreciate the sentiment and are now lobbying harder for a systems plan approach to the establishment of MPAs. The Sable Gully has been established as an MPA but this may have been done at the cost of establishing MPAs in the future. MPAs are only part of a conservation based integrated management plan, and this message may have been lost in the process of establishing the Sable Gully as an MPA.

We advocate a systems plan approach to the establishment of MPAs. However, we recognise the limitations of the conservation benefits of MPAs. For example, there is little benefit to MPAs if in the surrounding area destructive activity takes place. We endorse an integrated approach, based on conservation principles, to management of human activities on the ocean. In our view, such an approach means that we have to address, debate and discuss limiting (not just displacing) destructive activities including groundfish dragging, hydraulic calm dredging, scallop dragging, swordfish longlining, sand and gravel extraction and oil and gas extraction.

Suggested research directions

Future research could investigate how MPAs could be established as part of an overall management strategy, based on conservation principles.

Oil and gas development

Our marine interests are not confined to issues where fisheries developments may impinge on the health of the marine environment or coastal communities. In some forms of development, fisheries may be the victims rather than the perpetrators of ecological damage. In the late 1990s, the rate of oil and gas exploration in Atlantic Canada increased dramatically. Our primary concern is that the increased rate has occurred at the same time that national governments are discussing how to reduce fossil fuel use to address global climate change.

In 1992, the Canadian government committed itself to stabilising greenhouse gas emissions at 1990 levels by the year 2000 by signing the Framework Convention on Climate Change in Rio. In 1997, the Canadian government committed itself to reducing emissions to 6% below 1990 levels by 2008-12 by signing the Kyoto Protocol. In the autumn of 1998, the government called for more oil and gas exploration proposals for Atlantic Canada. While the government is developing policy to address global change, that same government is encouraging more fossil fuel extraction.

Another concern is the process to evaluate the environmental impacts of oil and gas development. There are various regulatory bodies requiring that oil and gas proponents assess environmental impacts of their projects. The combination of these processes we will refer to as an Environmental Impact Assessment (EIA). EIA is a process that includes public participation. Conservation, fishing and other agencies can register as intervenors and submit their environmental concerns.

We participated as intervenors in the Joint Public Review (combination of EIAs) of the Sable Offshore Energy Project (SOEP). SOEP is a proposal to extract natural gas from the Scotian Shelf. Throughout that process we were struck by the lack of information on regional distributions of marine life, most notably benthic invertebrates. When there is very little information on what species are where, it is very difficult to assess how they would respond to oil and gas activities. Throughout the EIA process, oil and gas activities were presumed to have minimal effect if there was an absence of knowledge on a particular issue.

The Joint Public Review exercise raised three issues. First, we need more information on benthic invertebrates (EAC, in conjunction with a natural history museum, has submitted a proposal to achieve that). Second, the EIA is fundamentally flawed because an assumption of the assessment is that if there is no information on an issue, (e.g., a species) then the oil and gas activities are deemed to have no effect. Finally, our experience was that the EIA mandate is not broad enough. The mandate does not include any analysis of how the project relates to our national energy policy (commitments to reduce greenhouse gas emissions). It does not include an analysis of cumulative impact in the context of existing or future oil and gas development. Further, the mandate does not require any analysis of the cost-benefit for residents of the exploration area.

The EAC is a member of an alliance of fishing and environmental groups calling for a moratorium on oil and gas development in important fishing areas.

Suggested research directions

Future research agendas might examine how environmental assessment processes could incorporate broader global issues, particularly energy consumption rates and global climate change. We would also like to see the process broadened to include cumulative impacts in the context of existing or future hydrocarbon development and other human activities.

Conclusions

Since the decline of formerly abundant groundfish stocks in Atlantic Canada, there has been considerable discussion on solutions to an inadequate management system. Methods to incorporate conservation into ocean activities have been proposed but the DFO management has been resistant to change. The greatest constraint to conservation is the lack of political will. This is partly because the regulatory bodies prefer the *status quo* and wish to be seen to be conceding to each sector involved.

How do we go from principles and policy to action? We advocate experiments, or pilot projects on a small geographical scale, designed to test fisheries management alternatives. For example, quota management has led to dumping and discarding. A reasonable approach would be to investigate whether an effort based fishery leads to greater conservation using an experimental approach. While management has been resistant to change, various policy makers have developed conservation based policies without knowing how they can be applied. It is also true that operational policies often override conservation based policies.

Our role in future research agendas is based on our broad approach to collecting information about the marine environment and providing a critical analysis of current marine policies. We are also action oriented and choose research projects that produce a concrete action or stimulate further discussion within government and universities, as well as in community groups and fishing associations. We are able to provide a unique perspective on issues because of our non-governmental status and our relative freedom from political pressures. We also do not do not profit from the harvesting or exploitation or marine resources. This puts the Marine Issues Committee in a unique position to provide information and analyses from a conservation and sustainability perspective. We are able to be critical of government institutions without suffering direct consequences of pointing out discrepancies in policies and conservation measures.

One of our strengths is that we have used the knowledge of fishermen, coupled with that of scientists to produce a broader view of the issues in the marine ecosystem. This research strategy has allowed us: (1) to involve fishermen and their knowledge in proposing solutions, (2) to gather extensive amounts of information with very little money, (3) to provide information for public education, (4) to approach marine habitat and fisheries policy issues with a broader perspective, thus allowing us to make well founded criticisms and suggestions to policy makers, and (5) to bridge the gap between science and activism.

As a citizen based advocacy group, we have had considerable influence because of our research oriented and critical approach to the analysis of marine policies. Our affiliation with fishers and fisher associations has been mutually beneficial. We have in several instances worked with academic and governmental institutions and would like to strengthen those ties as well as establish new ones. Although we appreciate being involved with institutions, the amount of work is overwhelming and increasing. This is, in part, because governmental agencies have decreased their environmental and natural history research activities. We do not feel we can replace these research activities because of our small budget, but we do feel we have a good sense of what

research is needed, and we have a lot in common with other community groups. We would like fisheries associations, community development associations and conservation groups to have increased influence on the research agendas of universities and government institutions. Such groups can have a very positive effect in implementing sustainability and conservation measures, which include both ecological and socio-economic factors.

References

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4.5 Multi-disciplinary research in fisheries from a social science and north American perspective

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Introduction: endogenous and exogenous multi-disciplinarity

Fisheries management is, without question, a multi-disciplinary enterprise. Research on fisheries by natural scientists means little without a firm grasp - whether social, scientific, political or economic - of the motivations, values, and bottom lines of those involved, whether they be commercial, sports, or subsistence fishers, or environmentalists, animal rights activists, or bureaucrats. Bringing such knowledge into fisheries management involves 'exogenous' multi-disciplinarity: crossing the divide between natural and social sciences. But we should be wary of focusing too much on this kind of multi-disciplinarity. Equally important, and perhaps more important in the long run, is 'endogenous' multi-disciplinarity, within either the natural or the social sciences. This too can be very challenging. Natural scientists might be surprised to find that anthropologists, economists, sociologists, geographers, political scientists and psychologists consider each other somewhat foreign, just as social scientists must be aware that there are major disciplinary differences among specialists in oceanography, the study of phytoplankton and productivity, ichthyology, fish genetics, population dynamics, marine ecology, and so forth.

My own background, unusual as it is, may be suggestive of what might be helpful to the effectiveness of multi-disciplinary work. My experience doing multi-disciplinary research is partly grounded in my own multi-disciplinary training and practice, as an 'ecological anthropologist' and partly in the extent to which I have worked with people from other social and natural science disciplines. In my writing I have collaborated with sociologists, economists, and political scientists. With two exceptions, in the hard clam project described below, my engagement in multi-disciplinary work with natural scientists has been through joint service on scientific committees established by public agencies. This includes the National Research Council of the U.S., an arm of our National Academy of Sciences, where I have served with biologists, geologists, physical oceanographers, and others on committees concerned with protecting and restoring the salmonid populations of the Pacific Northwest; individual transferable quota (ITQ) systems of fisheries management; and the broader challenges of sustaining marine fisheries (National Research Council, 1996; 1999a; 1999b). From 1979 to the present I have been a member of the scientific and statistical committee of one of the US regional fishery management councils. I also served a brief stint with an ICES committee on fisheries management, and I have been or am serving on numerous advisory committees to federal programmes concerned with the environment and fisheries.

My analytic skills are entirely those of a social scientist and humanist, but my domain is far broader (as evinced in an early graduate school publication on the concept of adaptation [Alland and McCay, 1974]). When asked to define what my

'professorship' was, I chose 'anthropology and ecology,' referring in part to the graduate programmes in which I participate. My graduate training was as much in demography, ecology, and medicine as it was in social or cultural anthropology. When I came to Rutgers University, I began to teach a panoply of multi-disciplinary (or a-disciplinary) courses to undergraduates, ranging from 'social and ecological aspects of health and disease' to 'human ecology of maritime regions.' Today I teach the latter course as well as 'human dimensions of natural resource management,' and 'environmental policy and institutions,' something of a stretch from anthropology. I suppose, then, that I am more inclined to multi-disciplinarity than many social scientists.

Multi-disciplinarity and changes in U.S. fisheries management

The importance of multi-disciplinarity for fisheries management is highlighted in recent changes in U.S. laws and management regimes. In the United States, the separate states retain jurisdiction and management authority out to three nautical miles (six in the case of several Gulf of Mexico states). In 1976 the US claimed exclusive jurisdiction to 200 nautical miles, following the trend at the UN Law of the Sea Conference, and the federal government became custodian of the area between 3 and 200 nautical miles, now known as the Exclusive Economic Zone, or EEZ. The enabling legislation of 1976 is now called the *Magnuson-Stevens Fishery Conservation and Management Act*; it established US claims *vis-à-vis* foreign countries and also set up a regional management council system for domestic fisheries management. In 1996 it was significantly amended through the *Sustainable Fisheries Act*. Most changes in laws to which I shall refer came about in 1996. Within these regimes, critical habitat must be identified and considered in fishery management plans. This 1996 requirement has nearly broken the regional fishery management system because of the under-development of the ecological and other sciences required to deal with habitat questions, much less what is required to address broader issues in multi-species interactions and ecosystem based management. Little is known about relationships between bottom sediments, larval settlement, current dynamics, fishing mortality and the abundance of particular, commercially or recreationally valuable fisheries. Fisheries specialists and the staff of management agencies recently scrambled to put together what they could to identify critical habitats in order to meet the bare letter of the law. Only too evident is the shallowness of their efforts and how far they are from the intent of the critical habitat provision, which can be interpreted as expressing recognition of the need for a far more ecological and hence multi-disciplinary approach to the challenges of conserving fish stocks (National Research Council, 1999a).

Another example is the US Congress' 1996 insistence that federal fisheries management take into account the needs of fisheries dependent communities. This builds upon earlier requirements that significant changes in allowable catches, seasons, or other management measures be evaluated in a cost-benefit framework, and that effects on small businesses be taken into account as well. These have ratcheted up the long extant requirements for some kind of social impact analysis, which heretofore have been mostly ignored. Hence the greater need for multi-disciplinary social science work in fisheries.

Yet another example is the provision that once a fish stock has been declared 'overfished,' measures must be put into place to ensure that the stock is rebuilt within a ten year period. This law, pushed by environmentalists in the 1996 legislation, has also nearly brought the management system to its knees. Another paper might dwell on the organisational crises created. For this paper I will merely note that this is an example of a legal requirement that would seem to call for 'exogenous' as well as 'endogenous' multi-disciplinarity. We need to know the effects of habitat and other environmental changes, as well as fisheries mortality, on both the decline and the rebounding, if any, of fish stocks. We also need to know how human behaviour will respond to the measures developed to restore 'overfished' populations. For example, in New England the management of cod and other groundfish is being done through restrictions on days-at-sea rather than by the imposition of catch quotas. How do changes in days-at-sea translate into fishing mortality? How might this differ among fishing fleets? How might it differ over time, possibly due to learning and development of new technologies? This clearly requires collaboration between natural and social scientists.

Legal mandates, agency culture, and the position of social science in fisheries

In the United States, social sciences have been marginal at best in the fisheries management enterprise even though we have a long history of claims for the importance of both the economic and social dimensions of fisheries. The system is run by biologists and formally with biology; informally, of course, economic and social factors make much of the difference, but this is relegated to the realm of 'politics.'

Since the late 1970s, the law for managing fisheries in federal waters has required economic and social analyses, but for the most part, they have been relegated to *pro forma* and inadequate descriptions of possible 'regulatory impacts.' Few such impact analyses have moved beyond the level of reports derived from a meagre set of previous studies or of abstract models of situations for which there are no data available. No data on the economics and social dimensions of fisheries are systematically collected by government agencies, a matter that is being addressed but has not yet changed.

The federal management law requires that decisions be based upon science, but there are two hedge factors, one of which is the qualifier in the phrase 'best available scientific data,' and the other of which is doubt that the social sciences, even very quantitative economics, qualify as science. Certainly most of the actors in fisheries management are disinclined to recognise sociology, anthropology, or economics as science; almost all of the management personnel, whether agency bureaucrats or scientists working in the various research arms of government, are trained in biological science. All natural resource agencies in the US have similar profiles: For example, the National Marine Fisheries Service has about 1900 employees; about 30 are economists; two, maybe three if you loosen the definition, are other social scientists. When the 200 mile limit and regional management council system was created in 1976, there were few people with the training and motivation required to carry out the more multi-disciplinary and social requirements of the law. As early as 1976 those requirements included paying attention to ecological, economic, social,

and cultural aspects in determining 'optimum yield' as well as deciding about limited access regimes.

Let me acknowledge, again, that social, cultural, and economic forces have played a major roles in fisheries management. They have often created 'optimum yield' targets that are above what more precautionary biological principles would dictate. In addition, they have provided tremendous resistance to limited access programs. Both of these conclusions are in need of revision, given recent changes in the US federal fishery management system. In determining 'optimum yield,' it is no longer (as of 1996) permissible to go above what would be suggested from a 'maximum sustainable yield' analysis, although one might still go below that because of social, economic, cultural, and ecological factors (putting into effect a 'precautionary principle'). And limited access is rapidly becoming a fact of fisheries life since the early 1990s, despite widespread philosophical objection to it when quotas or allowable days at sea are severely cut.

The relevant point for this context, on multi-disciplinary fisheries research, is that social, cultural, and economic factors are played out through the political process rather than through careful consideration of scientific socio-economic analyses.

Courts and a new recognition of social science in U.S. fisheries management

It is only lately that the US system has begun to make major structural changes that truly open the door to multi-disciplinary analyses involving social science. I have already noted a provision in the 1996 law that requires 'taking into consideration' the needs of fishing communities, and makes a strong statement about the importance of protecting them. But 'taking into consideration' is a weak command. Structural change has depended even more on intervention of the federal courts.

In 1993, a non-profit legal foundation in Boston, Massachusetts, the Conservation Law Foundation, sued the National Marine Fisheries Service (NMFS) for failure to properly manage the New England demersal fisheries (i.e. cod, haddock, yellowtail flounder, and other groundfish). This forced the New England Fishery Management Council to take stronger measures than before, although not enough to forestall the collapse of some stocks, which forced even more severe measures. This action was followed by a dramatic increase in environmentalist engagement in fisheries politics in the US, leading to some of the legislative requirements to which I have referred, i.e., identifying critical habitat and restoring overfished populations. One can surmise that the federal and state agencies involved welcomed the court decision, which effectively helped them do their jobs. Other court cases, however, are less welcome by the agencies because they are forcing an expansion of job descriptions.

Certain US federal courts have recently forced the agencies to pay more attention to the socio-economic impacts of fisheries regulation, in a situation best characterised as studied neglect. A federal district judge in the state of Virginia, Robert Doumar, has turned around a long train of court rulings that supported the fisheries management agencies by refusing to rule on the substance of what they did; only if they erred procedurally could appellants have a chance.

Triggered by Judge Doumar's rulings against the NMFS, the accuracy and appropriateness of scientific analyses is newly up for review by the courts. A handful of highly publicised cases challenging the agency's stock assessment methodology and other scientific matters has also led to Congressional intervention. Members of Congress demanded scientific review of fisheries management agency behaviour and decisions through the National Academy of Science and its consulting arm, the National Research Council. The enterprise of fisheries science is under close scrutiny. Courts are in effect forcing peer review of the biological science and mathematical modelling used in fisheries stock assessments.

The mounting critique has come to include analyses of economic impacts, as in the NMFS's plan for shark regulation, where the agency averaged catches over the number of licensed fishers as justification for its conclusion that there would be no significant socio-economic impact of a planned reduction in allowable catches. What they missed by averaging catches was the existence of nuclei of highly specialised, dedicated, and dependent shark fishermen.

A new tool provided to the courts is the statement in the 1996 *Sustainable Fisheries Act* on the need to consider the effects of regulation on fisheries dependent communities. Although this is muted by the much stronger attention given by Congress in 1996 to biological conservation and habitat, Doumar and other judges are willing to include it in their reviews of federal actions.

Cognisant of the threats posed by the courts, and even more the political pressures engendered by newly emboldened fisheries associations and local congressmen, the agencies involved have become alert to the need for better socio-economic analyses. By agencies I refer not only to the federal agency, the NMFS, but also to interstate commissions such as the Atlantic States Marine Fisheries Commission (ASMFC) and to the regional fisheries management councils.

The need for endogenous, social science based multi-disciplinarity, as well as exogenous cooperation between social and natural scientists is thus recognised and being supported in a variety of ways. What will this mean? What will it look like? To some extent it has already begun. Outlines can be discerned or are being drawn. I will briefly draw attention to two recent experiments in bringing social scientists more meaningfully into the fisheries process, via committee work, before depicting experiences in multi-disciplinary research. There is no question that most of the action is occurring within committees rather than research.

New England Fishery Management Council and endogenous multi-disciplinarity

In the context of drastic cuts in allowed fishing time, sharp limits on access, and overall gloom and doom concerning the traditional fisheries of New England, the regional fisheries management council director created a Social Sciences Advisory Committee (SSAC) in 1998. It is made up of anthropologists, economists, sociologists, geographers, and political scientists, some but not all of whom have been engaged in fisheries research in the region for many years. The committee parallels the Council's Scientific and Statistical Committee (SSC), a mandatory committee for all regional councils but only resuscitated in 1998 in New England. The SSCs for the

other seven regional councils have functioned regularly, to review scientific data and make recommendations to the voting members of the councils. Most of these have included social scientists. The Director and others had hoped that each of these new committees (the SSAC and the SSC) would immediately get to the task of evaluating the scientific bases (natural and social) for the fishery management plans, but members of both committees have had to spend time defining their mandates and learning how to work with each other. Each may be considered a case of endogenous multi-disciplinarity, and their infancies both show the challenges even among relatively like-minded professionals.

Endogenous multi-disciplinarity: some experiences

The present section concerns my 'endogenous' multi-disciplinary experiences working with sociologists, political scientists, and economists. One example is a recent book *Community, State, and Market on the North Atlantic Rim* (Apostle *et al.*, 1998). It is the result of four years' research and writing on the part of sociologists, a policy specialist and a political scientist, economist and anthropologist. Compounding the diversity of disciplinary approaches was a diversity of nationalities: Norwegian, Canadian, American. Not pretending to speak for the others, I will venture nonetheless to say that our relationships were synergistic. We learned from and with each other. The 'learning with' part may be particularly important to the success of multi-disciplinary ventures. We divided our 7-person group into 3 teams. Each team of 2 or 3 people, travelled, observed, and did interviews together in both Canada and Norway. We were problem focused rather than discipline focused. Through the joint interviews and observations we came to respect each other's approaches to issues and gaining information and to learn more about each other's theoretical and methodological frameworks. Thus, by the time we began to write, we had developed the shared knowledge and trust so important to effective communication.

I have worked even more consistently with a sociologist, Svein Jentoft. Our relationship grew out of an ambitious, if short lived, European project in fisheries multi-disciplinarity. It was instigated and supported by Jacqueline McGlade, a well known leader in fisheries policy and research. It was an international conference in Juelich, Germany, that sought to develop linkages between social sciences and fisheries scientists (although only social scientists were invited). The theme of user participation emerged as one of the major contributions of this effort, and from that Jentoft and I began several joint ventures. We were able to combine Jentoft's skills in organisational sociology and research experiences in Norwegian fisheries with my skills in critical ethnography and common property theory, and research experiences in North America. These experiences in endogenous multi-disciplinarity emboldened me, an anthropologist, to take on a sociologist as a post-doctoral associate at my institution. Douglas Wilson's very different training in sociology further enriched our theoretical work.

As interesting and rewarding has been collaboration with an econometrician. I am statistically and mathematically 'challenged,' to say the least, but I have now been co-author of several publications replete with formulae and estimates of probability. This is due to the happy circumstance of eliciting the interest of an economist in my institution in the research that I and my students had been doing with the surf clam

and ocean quahog fishery, the first in the U.S. to be managed with individual transferable quotas (ITQs). ITQs are seen as panaceas for the manifold economic problems of fisheries by many fisheries economists and other specialists, but not all. Many philosophical and political issues are raised by the profound change in property rights that they entail. What we have sought in our collaboration is an empirical investigation of the consequences of ITQs, an attempt to provide the objectivity of the scientific method to a very hot political issue. The collaboration has proven very fruitful between myself and the Rutgers agricultural economist, Adesoji Adelaja, and his graduate students in developing econometric models for understanding the effects of changes in a management regime upon the structure and dynamics of an industry. We are on the verge of embarking on another phase of this collaboration, responding to the needs of the Mid-Atlantic Fishery Management Council, which is perennially confronted with the question of how to appraise anecdotal claims about the effects of changes in the TAC (total allowable catch) or other management parameters on the structure of the industry. It is heartening to see the possibility that social science (at least in its more econometric form) might be accepted as a tool and source of information on a par with fisheries population dynamics and life-history studies.

Exogenous multi-disciplinarity: some experiences

The North American track record of multi-disciplinary fisheries research projects involving natural and social scientists is meagre and for the most part very new. What comes to mind are two very large multi-disciplinary efforts, neither of which has been fully evaluated. The first is a Canadian project, centred at Memorial University of Newfoundland: 'Sustainability in a changing cold-ocean coastal environment.' Among the project managers was a biological oceanographer, Richard Haedrich and three sociologists. The multi-faceted research ranged from primary productivity to artistic expression. However, there was a particular and salutary focus on inter-disciplinary approaches to collecting and integrating the knowledge of fishers into fisheries management. The project has spun off several new inter-disciplinary projects.

Such large-scale projects are ambitious and exciting but also extremely difficult to manage. As promising but easier to manage are smaller and more focused inter-disciplinary and multi-disciplinary projects. The issue of 'fishermen's knowledge' is the catalyst for some of these, as in work sponsored by the Island Institute of the State of Maine, which has involved a local fisher, anthropologist, economist and fishery biologists in using interviews to elicit information on past cod spawning events and other events that may have affected inshore cod populations. Connections with fisheries biology itself were indirect but significant: the results prompted greater attention paid to local stocks and the discrete events that might imperil them, leading to a multi-disciplinary and international conference on the topic in October 1997.

Opportunities for smaller-scale, focused inter-disciplinary research may be enhanced with the development of more research projects that require cooperation between members of fishing industries and government researchers. In North America such collaborative work is new and controversial (although it was the norm many years ago, when fisheries biologists depended on fishermen to catch specimens and lead them to the fishing grounds). Today it takes place within a very adversarial climate of

fisheries management and a management system that prides itself on the professional expertise of its scientists. Anthropologists, in particular, may have opportunities to observe the personal and institutional changes, and resistance to change, that follow from collaborative surveys, etc.; they may also find themselves of some use in helping translate between lay and expert cultures of knowledge.

Among the lessons I have learned from an attempt in the mid-1980s to bring industry, government and shellfish biologists together to address the problem of declining bay shellfish stocks in New Jersey was not to under-estimate the social and cultural diversity among those 'on the other side,' whether they be industry members or shellfish biologists. Another was how absolutely critical it is to select both industry members and biologists who have a particular bent or talent for reaching out to the other side. Not everyone can or will do this. A third lesson was that although our approach to the problem seemed at the time quite difficult and troubled, it was probably the most appropriate one to take given the high level of uncertainty and ignorance that prevailed about clams in New Jersey's bays. In retrospect, it was an excellent argument for adaptive management. We did learn as we 'muddled through.' And we were able to capitalise on what we learned by using the project to pressure for greater attention given to problems in hard clam biology and management.

Present and future themes for fisheries research

We can point to a number of fundamental trends underlying the conditions of US fisheries management, many of which apply equally on the other side of the North Atlantic:

* a decline in many of the most important fish stocks;
* a weakened trade position in the global markets;
* the consequences of development in the coastal zone, including competition for scarce waterfront land; the effects of pollution on fish habitats; the dilution and dispersal of fishing populations *inter alia*;
* allocation battles between (and within) commercial and recreational fishing communities;
* development of regionalised and participatory fisheries management institutions, including the Magnuson Act's regional management councils covering the 3-200 nm zone, the interstate management commissions (e.g. Atlantic States Marine Fisheries Commission) and a regionalised federal fisheries agency (National Marine Fisheries Service);
* the emergence of new actors in fisheries policy (including environmental NGOs, the law courts and pro-active congressmen) which challenge the positions of fisheries agencies and industry groups and suggest a pending 'crisis of legitimacy';
* increased media coverage, public awareness and political attention for certain fisheries (salmonids, large pelagics, New England ground fish stocks and any fishery interacting with popular marine animals); and
* awareness of a lack of licensing, training and vessel inspection for commercial fisheries.

At the same time and partly as a consequence, several new concepts are being introduced into fisheries management *viz.* (a) the precautionary approach; (b) essential habitat protection; (c) ecosystem approaches; (d) protected areas; (e) protection of fishing communities; (f) limited access and the creation of exclusive rights; (g) co-management; and (h) safety at sea.

Among the major themes for future research are likely to be:

* improving the predictive capability of fisheries biology (especially in relation to population dynamics);
* improving the credibility of science in the fisheries management;
* developing an ecological approach to management;
* coordinating the wide variety of federal and state institutions for research and management (e.g. relating to endangered species; marine mammal protection; water quality; watershed management; estuarine and coastal zone management);
* bringing the concerns and resources of fishing communities directly into the management process;
* creating limited access systems that make ecological and social - as well as economic - sense; and
* translating public awareness into public support.

The gaps in our knowledge are ubiquitous: we know little about the above. Accordingly we need to find better ways to deal with ignorance and uncertainty. Among the new standard responses to the problem - each of which betrays its own 'black hole' of knowledge - are:

* the precautionary approach, aimed at reducing risks;
* adaptive management, learning by doing and making the necessary adjustments;
* co-management, enlisting the help, talents and resources of fishers and others, and overcoming the lay/expert divide to mutual benefit;
* integrated management, coordinating the work of government agencies, NGOs, research institutions;
* rights based management, creating market based incentives for greater efficiency, and devolving some of the risks of ignorance and uncertainty to the level of individuals and firms;
* community based management, building on social networks, shared history and culture and commonly held use rights to find local solutions to problems fraught with ignorance and uncertainty.

Much more needs to be done to increase public and private commitment to research and experimentation in these and other areas.

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4.6 Discussion

Poul Degnbol (DIFR, Hirtshals, Denmark). It is interesting to reflect on the role of the biological sciences and the management institutions as seen through the perspective of the social sciences. To a political scientist it is a question of power; for anthropologists some kind of decision ritual; and for sociologists it is some form of social construction or rationality. Social scientists have various ways of analysing and explaining what biologists are doing. It is important to understand the cognitive basis of any science: the concepts of biology are social constructs - any applied science is contingent upon the management system - but biology is not a complete social construct. We simply reflect the context within which we are working.

The notion of 'rebuilding stocks', as required by US environmental law, brings us face to face with concepts of nature. What does it mean to rebuild stocks? Are we supposed to be restoring the marine environment as untouched nature? Or is it a case of rebuilding stocks for the purpose of sustainable exploitation by man, even if it means disrupting other elements of the ecosystem? Here we come back to the sustainable development issue. It is not a question of social *versus* biological sustainability. Social sustainability is contingent on biological sustainability. But we ought perhaps to explore the concepts of ecological sustainability held in largely urbanised communities and which are fed into the political discourse: this may be one way of getting closer to identifying - in social terms - what are likely to be acceptable changes and where the balance between the biological and social systems lie.

Jean Boncoeur (CEDEM, Brest, France). Management is rarely as simple as depicted in some economic models, but it appears that in the USA litigation is a much more powerful influence than it is in Europe and it clearly has an important role in multi-disciplinary research. But are we able to answer the questions which are asked of us? Multi-disciplinarity does need each partner to be aware of the premises of their own and other disciplines; and we need to be aware of each other's epistemological bases. The formalist point of view is that which characterises the work of most economists, but that does not prevent us from working with other disciplines. For an economist the main question in introducing conservation issues into fisheries management is to be able to define how people value environmental protection as compared with commodity consumption. It will involve a trade-off, but this will only be possible if we can find the means to value these different objectives; the same is true for economic v social objectives. If we cannot solve this methodological problem, commodity consumption will prevail.

Open discussion. Three main issues were raised (though these were mainly dealt with in the final discussion - see below):

(i) the meaning of social sustainability, especially in the context of inshore fisheries and the question of subsidies;

(ii) the role of NGOs in both policy and the research process;

(iii) the semantic difference between multi-disciplinary and inter-disciplinary research. The following distinction appeared to satisfy most, if not all,

participants: multi-disciplinary research involves cooperation between disciplines in addressing a common problem but where each discipline contributes directly through the application of its own epistemology, methodology and theoretical constructs; inter-disciplinary research involves much closer collaboration with different disciplines represented in the research team working on a specific project and implying a very detailed understanding of each other's roles and responsibilities. Inter-disciplinary research is much less common.

5.0 Concluding discussion

5.1 *Pavel Salz (LEI, The Hague, Netherlands).* Are we searching for consensus or are we trying to clarify our differences and reclaim our distinctive disciplinary territories? As researchers we are not placed outside the policy system but are an integrated part of it and here a key question is whether we can maintain our objectivity and independent epistemologies if we are incorporated within the system. Do we perhaps need a multi-disciplinary theory - which integrates our different disciplines, ascribes particular roles and defines our relationship to the policy process - in order to structure our approach to policy related research? The progress from single to multi-disciplinary research is not a simple or straightforward one: it is not a linear progression but relies instead on activating a network, drawing upon a variety of methodologies and epistemologies which may not sit comfortably with each other. There is also the question of primacy among the sciences. When discussing sustainability it seems reasonable to assume that the natural system lies at the basis of our paradigm and that all else follows. In this interpretation the biological sciences are *primus inter pares*. But the real driving force is our perception of the natural system and how we locate our disciplines in relation to the natural system. This also begs the question of the juxtaposition of monetary and ethical values: how do we decide how many seabirds or seals to conserve? Is it a question for science - ecological or economic science - to answer? Finally, we will need to decide what knowledge is required, what is relevant information and how this should be communicated to those who make the decisions. In this we will need new concepts and possibly new kinds of research institutes.

Michel Kaiser (University of Wales, Bangor, UK). Beware the modellers! The systems are not perfect and refinement is still needed. But there is a danger that those who put their faith in modelling believe they can deliver more than is actually possible. All models, including the new multi-species models, tend to ignore those factors that cannot be controlled. At the ICES Conference in Montpellier earlier this year on the effects of fishing in the marine environment, for example, only three papers addressed the basic issues of environmental change, yet this could generate massive turbulence in our fisheries management models. Similarly, there has been a tendency to heap the blame for habitat and ecosystem degradation on fisheries while ignoring other factors, such as pollution from agricultural run-off or from urban/industrial waste waters. Do we really need more detail and more sophistication about things we already know - especially at a time when we have less resources available to collect the data - or do we need simpler but more all-embracing models of the system? Modelling and simulation can certainly contribute to the provision of menus of options for politicians by explaining the consequences of actions in relatively simple terms.

One other problem we face, as scientific researchers, is our inability to respond quickly to changing emphases and new themes - for example, the ecosystem approach. The slowness of our response creates a vacuum which is being filled by non-experts who bend the ear of politicians with their advice. This may lead to the setting of unattainable goals, as with the American example of stock rebuilding. People in the know are losing control of the situation. Finally, how best can we learn from each other - and from the fishing industry? Pressures to introduce No Take Zones - and the opposition from the industry - may prove unnecessary. We need to know the economic (and social) costs of NTZs: who will lose or gain? what are the implications

for local communities? In the Fifth Framework most biological research programmes now specify the consideration of socio-economic impacts. This is what multi-disciplinarity is about.

Jeremy Phillipson (University of Hull, Hull, UK). Our discussions have focused on multi-disciplinarity in relation to research, policy advice and management. Ideally all three would be closely linked and multi-disciplinary in approach. In reality, however, there are obvious failures in the attempts to mesh these components together: each component - maybe all three - does not necessarily satisfy the test of multi-disciplinarity. The key foci for multi-disciplinary research would seem to be: (i) impact analysis and risk assessment, including the factors of uncertainty, unpredictability and unsustainability; (ii) the operationalisation of the ecosystem approach to management; (iii) the fisheries system and its contextuality i.e. the ecological, economic, social and political environments in which fisheries management is located; and (iv) the analysis of alternative management systems, including both the institutional frameworks and the management measures. But why is multi-disciplinarity given such a high priority in the present discourse in fisheries research? Does it reflect the increasing recognition of ungovernability, the complexity of the management system, a precondition for operationalising the concept of sustainable development ... ? Or is it simply a reflection of current intellectual fashion? Is it born of scientific logic or counsels of despair? And, finally, are we right in opting for a multi-disciplinary approach as opposed to inter-disciplinary projects: will the broader approach eventually lead to closer integration and to inter-disciplinary work?

Bjorn Hersoug (The Norwegian College of Fishery Science, University of Tromsø, Norway) In my paper, I indicated a pragmatic research agenda - women's participation, downstream activities, the role of aquaculture, the distributional effects of fisheries policy, *inter alia*. Some of these present opportunities for research within the social sciences; others, between the social and the natural sciences. If there is a common theme, involving all disciplines, it is surely the perspectives of the biological, economic and social sciences on the current management system. One joint task would be to evaluate the direct and indirect costs of the current system. If we talk of a new management system, then there are a number of theoretical questions to be considered *ab initio* - data requirements, model building, administrative arrangements, the location of fishermen's organisations, conservation agencies etc.. Are we settling for 'second best' in advocating multi-disciplinarity? Maybe, but the attempt to realign certain academic traditions which have not been in alignment so far seems to be an important first step towards an ideal solution. Should we be looking beyond fisheries to a more integrated management strategy? Maybe not: attempts within spatial planning to develop coastal zone management have made little progress to date.

The *open discussion* revolved around three broad themes;

(i) *The role of NGOs in the management system and the research community*, where it was suggested that NGOs have greater potential to influence decision makers than the research community. NGOs have changed their contact base - they are less insular and less concerned with improving their public profiles - and now liaise with a range of actors in the policy process - academics,

fishermen's organisations, administrators and government institutions at national and EU level. The basis of their involvement with the management system varies: at the European level, for example, discussions are taking place as to the part NGOs can play in the Advisory Committee - this applies particularly to the environmental NGOs but it can also apply in other areas. This development indicates a much stronger appreciation of the co-management project than was the case previously. One of the strengths of NGOs - as compared to fishermen's organisations, for example - is that they are better prepared in terms of communication and use of the media in winning popular public support. Their relations with the scientific community have clearly improved: previously, it was a case of 'us' and 'them'; now the NGOs are proactive in enlisting the support of scientific research which helps to circumvent problems before reaching the negotiation table. There is some danger that the research is too 'academic' and fails to clarify the issue or indicate the solution. But NGOs are also a victim of their own success - they are now being asked by governments to address particular issues on their behalf; and there is a danger of their incorporation within the policy process, so that they lose their influence as lobby groups. Hence, there is a constant struggle to maintain their influence: too radical and they are excluded; too compliant and their independence is under threat.

(ii) *The problems posed by 'participatory' research'*. Following on from the positional problems of the NGOs, there was some discussion of the costs and benefits for particular disciplines of incorporation within the policy community and the linking of research to policy advice. Some disciplines, - notably fisheries biology and, to an increasing degree, fisheries economics - are 'advice driven', in the sense that their internal research agendas are partly set by the management system and it becomes difficult to move the agenda to a new, and freer, domain. Despite the claims that the prior role of such sciences is essentially to produce knowledge and not to advise, there may be a high price to pay for incorporation. The problem is not so much one of research integrity - although the criticism is raised from time to time - as a question of independent control of the research agenda. Institutes which undertake policy research do not manipulate or distort the results for the benefit of their clients, but they will present their findings in particular forms convenient to the policy process. It is, however, important to distinguish between the two functions - the production of knowledge and scientific advice on policy - and to recognise that there are tensions between the two. Maybe there is a role for the social sciences, with their tradition of independent criticism and their position largely outside the policy community, to assist in the definition of an independent research agenda and through their critical analysis to act as watchdogs over the integrity of the research process.

(iii) *Developing an independent theory of multi-disciplinary research in fisheries.* Arising out of the comments by *Salz*, there was a considerable debate on whether a multi-disciplinary approach to research issues called for the development of a new, overarching theoretical construct. Although it was recognised that one cannot develop science from a complete abstraction and there was a need to cultivate common conceptual ground to communicate

effectively, the requirement for new theoretical models was rejected by most participants on the following grounds: (a) Efforts to develop a grand unifying theory in the past have proved generally unsatisfactory: we do have a lot to learn from looking at each others' domains but we do not need to subordinate our existing constructs to achieve this. (b) What matters is not new theory but the identification of key problems and the use of disciplinary strengths in a more focused way: we need to use our existing tools, apply them to the real world and discover, through practice, whether we do need new tools, methodologies or theories. (c) There is the risk of a breakdown in cooperation in the attempt to develop a 'unifying construct' which may appear to privilege any one discipline over any other. (d) The merging of disciplinary research and the development of new theories would seem to have more relevance to inter-disciplinary research than to a multi-disciplinary approach to particular research issues. It was, however, recognised that, at present, policy makers are continually weighing the advantages of one advice stream against another and that putting disciplines together in *ad hoc* way may still lead to a lack of coherence in the message and the opportunity for policy makers to play one perspective off against another.

5.2 *Concluding remarks (David Symes)*

Although the papers prepared for the workshop - in their full versions - identified well over 50 research topics, our discussions have not sought to elaborate an agreed agenda but rather to explore the scope for multi-disciplinary research. The papers, as expected, were dominated by a disciplinary rather than problem oriented perspective. Each approached the question of multi-disciplinary research as a more or less logical extension of existing research trends - a path dependent approach, in fact - which made for few surprises and little controversy. With one or two exceptions, the papers appear to suggest that when we apply our science to fisheries management we detach ourselves from the conceptual underpinnings of the particular discipline. This may be a good sign as far as multi-disciplinary cooperation is concerned in that we are willing to set our philosophical baggage to one side, but there is a danger in allowing ourselves to become footloose. Most of the research themes touched upon the papers are not new: multi-disciplinary research is not necessarily about inventing new topics but about reflecting upon existing themes from different disciplinary perspectives.

The reasons for multi-disciplinary research are obvious: we are beginning to sense the limits to single disciplinary approaches to such a complex management problem as fisheries. Already different disciplines - especially within the broad definition of the economic and social sciences - are beginning to invade the established territories of other disciplines; whether in a spirit of apostasy, missionary spirit or intellectual imperialism is not clear. On the other hand, we still tend to view fisheries research as a discrete and virtually unique field. As a result, we rather overlook parallel experiences of both research and management in neighbouring areas such as agriculture and forestry. And we tend to ignore the relevance of other policy areas such as regional development. We even fail to incorporate aquaculture within the scope of our research activities. To a degree, we are merely mirroring the isolationism of fisheries policy *per se*. One of the key questions to be addressed through multi-disciplinary research is the discordant spatial and temporal frames for research, advice

and the political process. Partly through the incorporation and non-incorporation of particular disciplines, we - as researchers - are tending to work on very different geographical and time scales: this adds to the incoherence of our message.

Implicit in the notion of multi-disciplinary research is the fact that we will be dealing with a wide array of information, expertise, scientific conventions and in several different languages. As a first step, therefore, should we be looking to recruit new information or to re-examine and reassess existing knowledge as the means of providing better advice on policy matters? Probably, the latter. Multi-disciplinary research implies working in parallel rather than in closely integrated programmes, where the particular chemistry of individuals has more to do with the success or failure of the project than the complementarity of research methods. Multi-disciplinarity implies peaceful coexistence rather than forced integration or territorial partitioning.

6.0 Analysis

Although the original expectation from the workshop was that it would help to generate a more or less comprehensive agenda of future policy related research in fisheries and so establish a context for the contribution of the social sciences, in the event the discussions focused more generally on the inadequacies of the 'scientific paradigm', the nature of fisheries management, the relationship between the two, and the need for a multi-disciplinary approach to fisheries research and, by association, to fisheries management. The following observations summarise the main conclusions from the workshop.

Existing research

In certain disciplinary areas considerable progress has been made in refining the basic approach, developing the information base, increasing the mathematical sophistication and improving our knowledge of specific aspects of fisheries and their management. There was, however, a broad consensus that existing forms of research were beginning to approach the limits of their utility for the management process. In all disciplines, there are opportunities to fine tune the research methodologies, identify new topics for investigation and improve the dissemination of research findings. But it was generally recognised that such intrinsic developments could only bring a marginal benefit to the management process. At present the research agenda suffers from a lack of coordination (both within and between different disciplinary areas), from unconformity of approach, from a lack of temporal and spatial synchronisation and from tensions between 'advice driven' and more basic research. Moreover, the underlying need to establish long-term sustainability of resource use is being compromised by a general insistence that particular research areas address what are essentially short-term issues. Possibly the greatest weakness of the current research system is that it remains highly fragmented, introspective and lacks a sense of creative connectivity between the participating disciplines. As a consequence, the contribution of research to an understanding of fisheries and their management needs has to face what are, in effect, self-imposed constraints.

Towards a new paradigm

A persistent theme running through most of the papers and much of the discussion was the need for new paradigms to model (a) the fisheries system, (b) the management process, and (c) the research design. Although the need for new paradigms was made very clear, their shapes and structures were less so. Certainly they would involve the dismantling of systems presently dominated by simple and partial relationships and the building of more comprehensive (and, therefore, more complex) systems which seek to bring together the biological, economic and socio-cultural factors and which engage all relevant disciplines in a more integrated and purposive way. The interrelated paradigms would need to address the following: (i) a broadening of the objectives for fisheries management to include both ecosystem integrity and diversity, on the one hand, and social equity, on the other; (ii) a more determined ambition for the development of a long-term strategy for sustainable development rather than a preoccupation with solutions to recurrent short-term problems; (iii) the issues of uncertainty and risk assessment as applied to both natural and human behaviour

within the fisheries system; (iv) the incorporation of relevant interests groups within the policy community and the decision making process; and (v) the political realities of decision making in relation to fisheries management.

Multi-disciplinarity

Central to the notion of a paradigm shift towards a more holistic form of fisheries management is the development of a multi-disciplinary approach to key areas of policy related research. Not only is the emergence of multi-disciplinarity an inevitable consequence of the perceived limits to research conducted within the frameworks of particular disciplines, it will also serve to enrich the research experience, create a better understanding of the highly complex fisheries system and provide greater utility for those responsible for fisheries management.

A multi-disciplinary approach is preferred at this stage to the framing of inter-disciplinary projects, which demand a greater level of collaboration and integration of the research process. A multi-disciplinary approach involves cooperation between relevant disciplines in addressing common problems. Although research will still be undertaken mainly, but not exclusively, within established disciplinary frameworks, there will need to be a commitment to develop a more informed awareness and understanding of the other disciplines, to pool results and to discuss the findings openly and without prejudice with a view to providing complementary and coherent advice to policy makers. The value of multi-disciplinary discussion was amply demonstrated within this workshop. Whether it is possible, at this stage, to go beyond this level of collaboration and develop a more integrated approach and a common language is uncertain. Even though a multi-disciplinary approach seems a logical and not very radical progression, it is still likely to confront a number of institutional barriers within both the research and policy communities, which it will take time to break down.

Multi-disciplinary research and the Fifth Framework Programme

At several points in the discussion emphasis was placed on the need to change the existing research culture as a pre-requisite for developing a multi-disciplinary approach to fisheries and their management. While some changes can only be orchestrated from within the disciplinary institutions themselves, there is clearly an important role for those who commission policy related research to act as a catalyst for change. Those who pay the piper should call the tune. The Commission's Fifth Framework Programme, in its outline form, appears to provide such a catalyst, firstly by targeting research funding on 'key actions', secondly by emphasising a multi-disciplinary approach involving academic researchers, industry and users, and thirdly by insisting that research projects should, where appropriate, take fully into consideration the social and economic implications of their findings.

It will not be particularly easy to implement such an agenda. Although the present workshop reveals a willingness among the different disciplines to collaborate, this openness does not extend to all members of the scientific community. A number of eminent scientists remain to be persuaded of the benefits of a multi-disciplinary approach. This scepticism is one reason why the workshop came down heavily in

favour of cross-disciplinary discourse on mainstream issues as opposed to inter-disciplinary projects. Nor will a multi-disciplinary approach be easy to manage either at the level of research or, more particularly, by the research commissioning organisations. The clustering of research projects represents one opportunity for developing multi-disciplinarity without having to run the risk of ill-matched partners within artificially contrived inter-disciplinary projects. Having sent fairly clear signals to the research community concerning the relevance of a multi-disciplinary approach, it will surely prove counter-productive if research projects or concerted actions are turned down on the grounds that they are too broadly constructed or potentially difficult to coordinate. Having called the tune, the piper should be paid!

Annex 3: Programme

European Social Science Fisheries Network: FAIR CT95 0070
Workshop on Multi-Disciplinary Research in Fisheries Management
Sophienberg Castle, Denmark, 13-14 April, 1999

Coordinator: David Symes
Manager: Jeremy Phillipson

Local Workshop Organiser: Peter Friis

Tuesday 13th

0900 - 0930 *Introduction*

0930 - 1230 *Scientific and Environmental Research*

Chair: David Symes

Presentations: Carl O'Brien
Poul Degnbol
Michel Kaiser
Euan Dunn

Discussants: Bonnie McCay
Dirk Langstraat
Nancy Shackell

[1030-1100 *Coffee*]

1230 - 1400 *Lunch*

1400 - 1700 *Economic Research*

Chair: Niels Wichmann

Presentations: Jean Boncoeur
Pavel Salz
Peter Friis
Dirk Langstraat

Discussants: Torben Vestergaard
Euan Dunn
Christian Lequesne

[1530 - 1600 *Tea*]

Wednesday 14th

0900 - 1230 *Social and Political Research*

Chair: Dirk Langstraat

Presentations: Bonnie McCay
Torben Vestergaard
Nancy Shackell
Christian Lequesne
Bjørn Hersoug

Discussants: Poul Degnbol
Jean Boncoeur

[1030 - 1100 *Coffee*]

1230 - 1400 *Lunch*

1400 - 1600 *Research Agenda*

Chair: David Symes

Discussants: Pavel Salz
Michel Kaiser
Jeremy Phillipson
Bjørn Hersoug

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