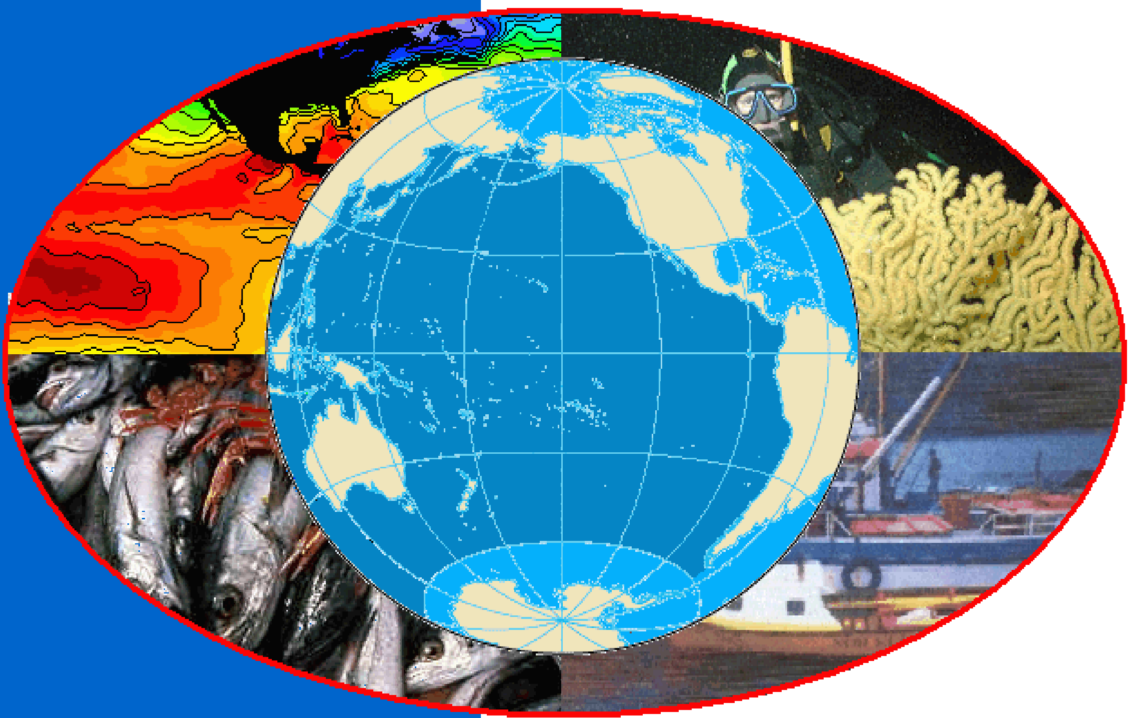
Ecosystem based approach:

a comparative assessment of the institutional response in fisheries management within APEC economies: the case of demersal fisheries (Phase I)



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Faculty of Nature and Oceanographic Sciences

APEC Fisheries Working Group 02/2005

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EXECUTIVE SUMMARY

This document is the final report of the project APEC FWG 02/2005 "Ecosystem based approach: a comparative assessment of the institutional response in fisheries management within APEC economies. The case of demersal fisheries (Phase I)". It was proposed to APEC by Chile, and the co-sponsoring economies were Canada, Chinese Taipei and the United State. This project has been carried out by Universidad de Concepción (Chile).

The project was designed as a desktop job. Part 1 analyses the results of a questionnaire sent by e-mail to 265 contacts with the objective of obtaining an inside, qualitative evaluation of the importance of fisheries in each economy; characteristics of their fishery regulations, the fishery authority and their decision-making process; knowledge of APEC; knowledge of ecosystem-based approach to fisheries management (EBA); application of EBA in each economy, and problems and constraints for application of EBA. Return rate was 4% only, with two answers from NGO officials from Southeast Asia, and another 9 from science officials from government or government-related agencies from Australia, Canada, Chile, Chinese Taipei, Mexico, Peru, Philippines and Viet Nam. Three responses were from third-party correspondents who received our query from direct contacts.

Part 2 is a review and analysis of fishing laws from APEC economies, which were obtained from Internet, exclusively. The reasoning behind this section is that the application of ecosystem-based management in fisheries ought to be reflected in the legislation framework that regulates the utilization of living aquatic resources. So far as we have been able to find, all fishery legislation in APEC economies is based, either on the principle of common property (*res communis*) or the principle of no-owners (*res nullius*). Through fishery legislation, economies assume control of the resources and establish access rules and conditions for use.

Part 3 of this report analyses ecosystem-based approaches to fisheries management obtained and selected from international literature after a systematic search by both Internet and scientific journals. There is an overview of ecosystem approaches to fisheries (EAF or EBA) and considerations, management procedures, implications, proposals of a framework for EAF, a four-step procedure proposition, review of indicators, criteria for evaluation of indicators, and so on.

The opinions in this report are the exclusive responsibility of the principal author and do not imply any commitment whatsoever from the Universidad de Concepción, the Undersecretariat of Fisheries (Chile) or the APEC Secretariat.

Some of the main results of this desk job work are:

- Our correspondents from APEC economies consider that industrial fisheries are highly important from an economic perspective, while the importance of artisanal fisheries is more social than economic.
- The focus of our project —demersal fisheries— seems to be important for APEC economies. None of our correspondents disregarded this type of fishery in their

economy. It means any measures applied to them could have remarkable implications, more so in the case of international agreements.

- There is variability in the importance of different resources for each economy's fishery sector. Fish as marine resources have higher economic than social importance, while crustaceans and mollusks are more evenly distributed. These may be related to the greater incidence of crustaceans and mollusks in small-scale artisanal fisheries in some APEC economies.
- The coastal areas seem to be the most relevant for fishing, taking into account that for our correspondents that area varies from 5 to 15 nautical miles in width from the coastal line.
- Most of our correspondents agreed on the very high complexity of fishery regulations in their APEC economies, while their opinions were more evenly distributed on their efficiency. With regard to the last point, there is no relation between the historic backgrounds of each economy's legislation (e.g. Anglo-Saxon, Roman or Asiatic) and the opinions expressed in our poll.
- Regulations have very high complexity and it is the predominant opinion with respect to resources and environmental protection, but the bias is not as great as in the case of fishery legislation. There is also a more positive opinion on the efficiency of the law. Interestingly, NGO officials were the most negative in their views on these points.
- The position of the fishery authority within the government varies among economies. Nevertheless, Ministry (Secretary) or Sub-Ministry (Undersecretary) levels within the executive predominate, with (in some instances) a variety of midlevel bodies with counseling or executive capacities, where different components of the fishery sector can express themselves.
- 45% of the correspondents claimed to have some knowledge of APEC's Political Agenda for the Marine Environment, while 18% indicated not to know about it. This level of knowledge can be considered poor, particularly when all those who answered the questionnaire are scientists or stakeholders closely linked to the fishery sector in their economies, and seem to imply a low level of dissemination of APEC policies among the economies.
- Most of our correspondents claimed a thorough knowledge of ecosystem-based approach to fisheries management. In fact, none of them stated ignorance of EBA. Most of them indicate that EBA are applied to some fisheries, but at the same time say the application is largely conceptual, that is, there are policy statements about the political decision to implement this approach to fishery management. Also, they vary in their appreciation of the time scale for the operational application of EBA.
- In opinion of our correspondents, the main problems and constraints they perceive for the EBA-implementation to fisheries in their economies are insufficient knowledge of ecosystems, single-stock management paradigm, lack of technical and financial capacity, fishermen's opposition, local economy *vs.* global markets conflicts, and conservation *vs.* exploitation conflicts.

- Access via Internet to legal documents in English or Spanish languages pertaining to fisheries (laws, acts, bills, regulations, etc.) included 16 APEC economies. The scope, depth and relevance of the information accessed are variable among economies. All APEC economies are parts to legally-binding International Treaties, Conventions or Agreements related to fishery resources, endangered species protection, environment protection, international trade, etc. These imply that stakeholders have to consider many different aspects in their activities and that there can be important cases of overlapping jurisdictions or (quite the opposite) gray areas not included in an economy's legislation. Table 2 summarized the most relevant information collected about legal frameworks for fisheries in APEC economies. Table 3 summarized the most relevant Internet pages visited, where information about legal frameworks for fisheries in APEC Economies can be found.

- Irrespective of the economic, social or cultural importance of fishing, all economies have developed a legal framework and an administrative structure to manage their fisheries. Also, even though there is a variety of governing systems in APEC economies, all have established a central fisheries management agency within the executive branch.

- Specific operational references to management under EBAs in the legal framework of the economies analyzed were not found, even though there are Policy Statements to that effect in Australia, Canada and the USA. The Australian Government considers ITQ's as a basis for ecosystem-based management. The nearest approach can be seen in the Canadian and Australian legislation, where the fishing authorities have issued general or species-specific guidelines whereby it is stated that fishing operations should be managed to minimize their impact on the structure, productivity, function and biological diversity of the ecosystem.

- It can be seen from the legal framework of APEC economies that most of them have mechanisms to implement area-based restrictions to fishing. Nevertheless, it must be considered that these regulations are applied usually to satisfy short-term objectives, such as protecting spawning areas during the reproductive season or protecting over-exploited beds of benthic organisms, like bivalve mollusks. As far as we have been able to investigate, these measures are applied within the framework of traditional, single-species fishery management, but not for an ecosystem-based approach to fisheries management.

- Marine Protected Areas (MPAs) could be included in EBA management, and many APEC economies have established them, but it must be considered that most of them have not been created with fishery-oriented objectives and are not under fishery authority jurisdiction. Rather, they are the result of environmental conservation policies and their management goals are consistent with environment or ecosystem protection from human intervention. There is an exception in Chile's fishery law. In fact, it created the figure of Management and Exploitation Areas for Benthic Resources, which are assigned to artisanal fishermen, and established Marine Reserves to protect and manage areas important for the sustainability of fishing resources. Similar figure of this kind of MPA can be found in the Peruvian fishing law.

- In order to incorporate ecosystem considerations into fisheries management, the primary policy goals and high priority objectives, would be to rebuild depleted stocks, to take into account wider fisheries effects (e.g. bycatch issues), and to make better use of the ecosystem, to reduce risk of irrecoverable resource damage and economic/social crises.
- The implementation of an ecosystem-based approach to fisheries management can have some potential areas of conflict, including lower quotas to fisheries in order to address ecosystem issues such the needs of predators; conflicts between consumptive and non-consumptive objectives and stakeholders; conflicts between different primary fishery sectors such as demersal and pelagic; conflicts between different groups of users within each primary sector, such as the handline and trawl sub-sectors; conflicts between mining and fishery stakeholders; conflicts between the aquaculture industry and, for example, capture fisheries; conflicts between the users causing marine environmental degradation and fishers; conflicts between new fisheries and existing ones, and so on.
- According to FAO (2003), an ecosystem approach to fisheries strives the balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries.
- Two institutional features of traditional fisheries management have been widely considered to have been important in the common failure of fisheries around the world and they are the prevalence of open access fisheries, and an almost ubiquitous reliance on centralized and top-down approaches to management.
- In addition to the incentives achieved through acceptable of user rights and co-management, the short-term impacts, on fisheries in particular, of implementing EAF will frequently require the consideration and use of other incentives that can play a role in encouraging stakeholders to accept and adhere to the requirements of the approach. Some possible areas for creating better incentives are (FAO, 2003): improvements of the institutional framework (including better management, research and compliance); developing collective values for sustainable use through education, training and dissemination of information; implementation of non-market incentives such as through taxes or subsidies; the creation of market incentives such as ecolabelling, and the implementation of tradable property or access rights that provide an incentive to the owner to ensure that the value of the right does not fall through overexploitation.
- In this project, the ecosystem framework for fisheries management proposed by Shannon and Moloney (2004) for the Southern Benguela upwelling system has been selected, due to that model is an excellent example to follow by developing economies specially. It includes a "four-step framework" as follow: first, static ecosystem models to highlight important interactions by assessing the net trophic impacts of each species on all the others; second, a dynamic simulation approach, indicators quantifying interactions strength and functional impacts to provide information on the size of impacts on ecosystem components when a fishing resource

is overfished; third, dynamic simulations to suggest some possible short- and long-term ecosystem effects of altered fishing under strategies developed and selected using standard single-species models; and fourth, to take into account the net combined ecosystem effects of the revised strategies for all fisheries in the ecosystem.

- The focus of fisheries management is on situations with limited knowledge of the resource base, and limited economic resources for research, then indicators selected and discussed area those that showed at least some perspective relative to criteria of acceptability to stakeholders, observability and relation to management. In Table 4 are exhibited these three criteria subdivided into several scoring properties. The relevance of each indicator for each property can be evaluated with a simple numerical system similar to a traffic-light approach. Indicators that can be considered are single population indicators (Table 5), indicators of the total resource base ("multispecies indicators", Table 6), habitat-related indicators (Table 7), and indicators of the biological production base (i.e. the wider ecosystem, Table 8).
- Trade-offs in groundfish fisheries and in ecosystem scale optimization of fisheries management policies were also reviewed, including several other papers from Bulletin of Marine Science 74(3), 2004.
- A short review of ecosystem-based management and its application to the North Pacific (PICES) is also included.

CONTENTS

GOALS OF THE PROJECT

The goals have been established in page 4, paragraph 1 of the project proposal, and they are:

- To outline the current decision-making in fisheries management process in each economy.
- To carry out a comparative analysis of the integration of the Ecosystem based Approach (EBA) in fisheries management and sectoral decision-making process within APEC region.
- To discuss/propose institutional mechanisms and operational management tools to incorporate the EBA in the fisheries administration with emphasis in demersal fisheries.

MAIN QUESTIONS

The project will be oriented to establish a common base in order to answer the following main questions (page 4, paragraph 4 of the APEC Project proposal FGW 02/2005):

- Have strategies been developed, within the fisheries management system, to implement EBA?
- What does the EBA mean for each economy and how it is implemented?
- What are the main problems and constraints observed in the implementation of EBA in fisheries management in each economy?
- Which is the degree of success in the implementation of the EBA in each economy?
- What are the common and different issues among the economies in regard to EBA?
- What are the main considerations of EBA taking into account in demersal fisheries?
- How is (or could be) the EBA for fisheries management applied in demersal fisheries? (study cases).

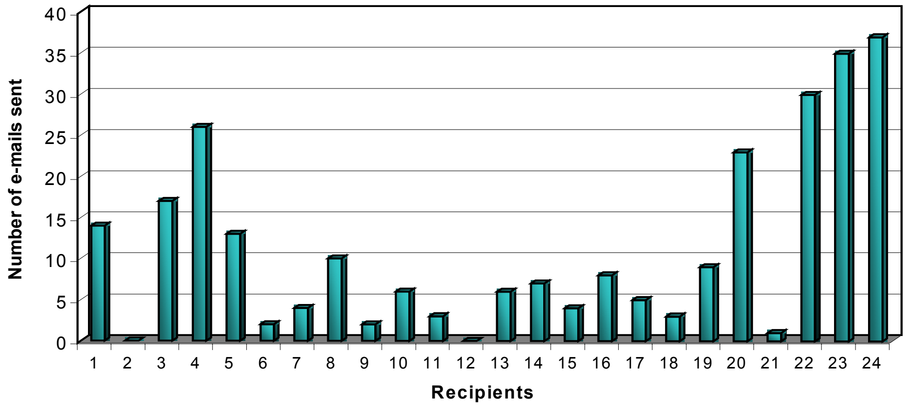
ELECTRONIC QUESTIONNAIRE

According to the characteristics of this project, the main inputs might be obtained from questions using as tool a questionnaire that was sent by e-mail to. The questionnaire (Annex 1) was formulated taking into consideration the objectives and questions formulated by the project.

PART 1. ANALYSIS TO THE ANSWERS OF THE QUESTIONNAIRE

1.1. The characteristic of fisheries in each APEC economy

To obtain an inside evaluation of the characteristics of the fishery sector in each APEC economy we devised a questionnaire that was sent by e-mail to 265 contacts (Figure 1).



CODE	Economy (in alphabetic order) or Organization
1	Australia
2	Brunei Darussalam
3	Canada
4	Chile
5	Chinese Taipei
6	Hong Kong
7	Indonesia
8	Japan
9	Malaysia
10	México
11	New Zealand
12	Papua New Guinea
13	People's Republic of China
14	Peru
15	Philippines
16	Republic of Korea
17	Russia
18	Singapore
19	Thailand
20	United States of America
21	Viet Nam
22	Others (CPPS, UNESCO, ASEAN, NGOs, etc.)
23	Marine Resources Working Group
24	Fisheries Working Group

Figure 1. Distribution of questionnaires sent by e-mail

We tried to target as many correspondents as possible from different areas (academics, public servants, businessmen, fishers) even though the coverage was biased by our own professional activity and the area of the world here we are inserted. Thus, many of our correspondents were fishery or ecology researchers from Australia, Canada, Chile and USA, while we did not contact anyone from Brunei-Darussalam or Papua New Guinea, for example. To try to counterbalance the shortcomings of our choice we asked people to re-send the questionnaire to their own contacts and we received a number of answers from such third parties.

The questionnaire (Annex 1) was designed to provide a qualitative, broad assessment of the following:

1. Importance of fisheries.
2. Characteristics of fishery regulations.
3. Fishery authority and decision-making.
4. Knowledge of APEC.
5. Knowledge of ecosystem-based approach to fisheries management (EBA).
6. Application of EBA to fisheries.
7. Problems and constraints for application of EBA to fisheries management.

We received only 11 answers to our query and, considering that 3 of those responses were from third-party correspondents, the answering rate was around 4%. With the exception of two questionnaires from NGO officials from Southeast Asia, the remaining 9 correspondents were science officials from government or government-related agencies from Australia, Canada, Chile, Chinese Taipei, Mexico, Peru, Philippines and Viet Nam.

The paucity of returns does not allow a rigorous analysis of the characteristics of fisheries in each economy from the point of view of local actors. Nonetheless, some elements can be analyzed. Figure 2 shows the economic and social importance our correspondents assigned to industrial and artisanal fisheries. They consider that industrial fisheries are highly important from an economic perspective, while the importance of artisanal fisheries is more social than economic.

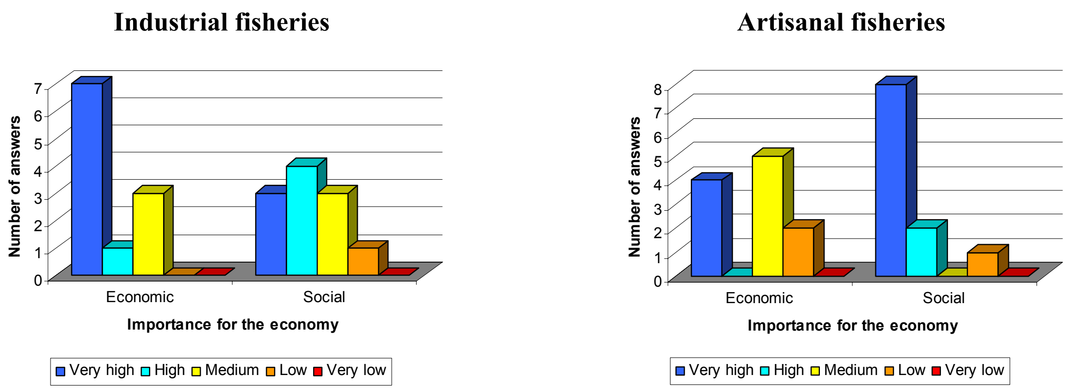


Figure 2. Relative importance of industrial and artisanal fisheries for APEC economies, according to respondents of the questionnaire.

The focus of our project —demersal fisheries— seems to be important for APEC economies. None of our correspondents disregarded this type of fishery in their economy (Figure 3). This means any measures applied to them could have remarkable implications, more so in the case of international agreements.

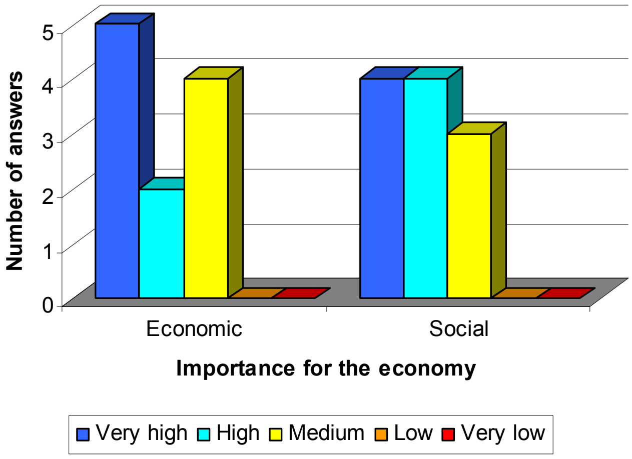


Figure 3. Evaluation of the relative importance of demersal fisheries for APEC economies

There is variability in the importance of different resources for each economy's fishery sector. According to the results from the questionnaire (Figure 4), fish as marine resources have a higher economic than social importance, while crustaceans and mollusks are more evenly distributed. These may be related to the greater incidence of crustaceans and mollusks in small-scale or artisanal fisheries in some APEC economies.

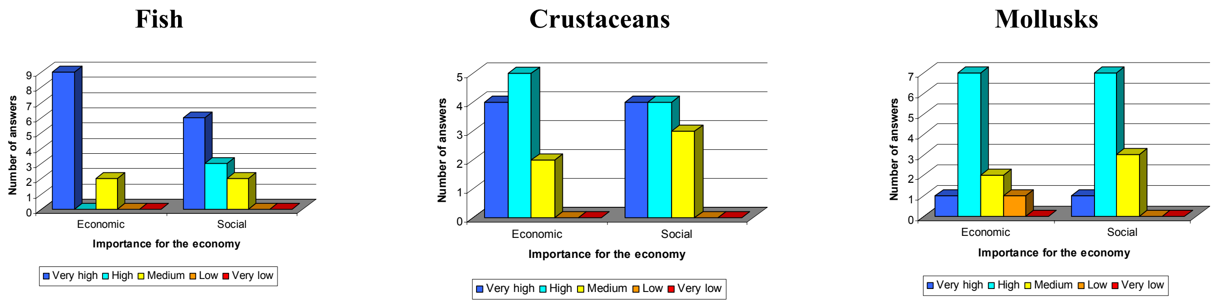


Figure 4. Evaluation of the relative importance of three groups of fishing resources for several APEC economies.

The coastal areas seem to be the most relevant for fishing, taking into account that for our correspondents that area varies from 5 to 15 nautical miles in width from the coastal line (Figure 5). This notion seems consistent with the known distribution of the most important fishery resources of the world. Fisheries within the Economic Exclusive Zone or the high seas target highly migratory species, such as tunas or mackerels, and they require high level of investment, thus they seem to have a higher economic than social importance. Also, an important number of APEC economies do not have oceanic fishing fleets, which could explain the low to very low importance value assigned to offshore fisheries.

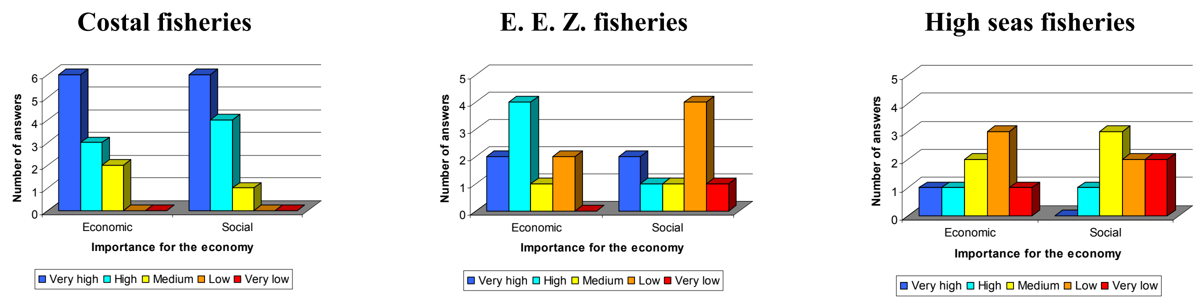


Figure 5. Evaluation of the relative importance of three fishing areas for several APEC economies.

Most of our correspondents agreed on the very high complexity of fishery regulations, while their opinions were more evenly distributed on their efficiency (Figure 6). With regard to the last point, there is no relation between the historic backgrounds of each economy's legislation (e.g. Anglo-Saxon, Roman or Asiatic) and the opinions expressed in our poll.

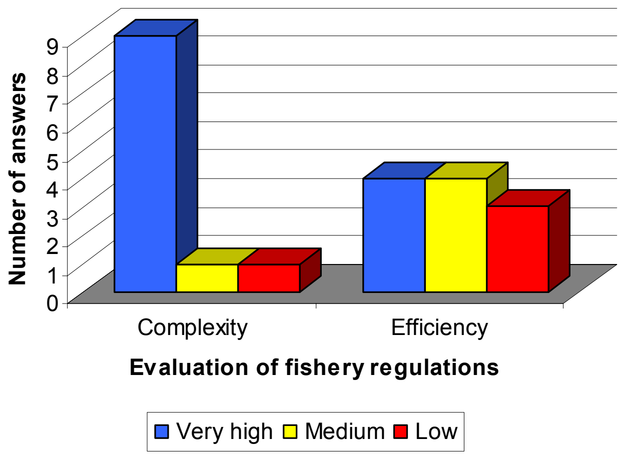


Figure 6. Evaluation of the complexity and efficiency of fishery regulations for several APEC economies.

Regulations have very high complexity and it is the predominant opinion with respect to resources and environmental protection (Figure 7), but the bias is not as great as in the case of fishery legislation. There is also a more positive opinion on the efficiency of the law. Interestingly, NGO officials were the most negative in their views on these points.

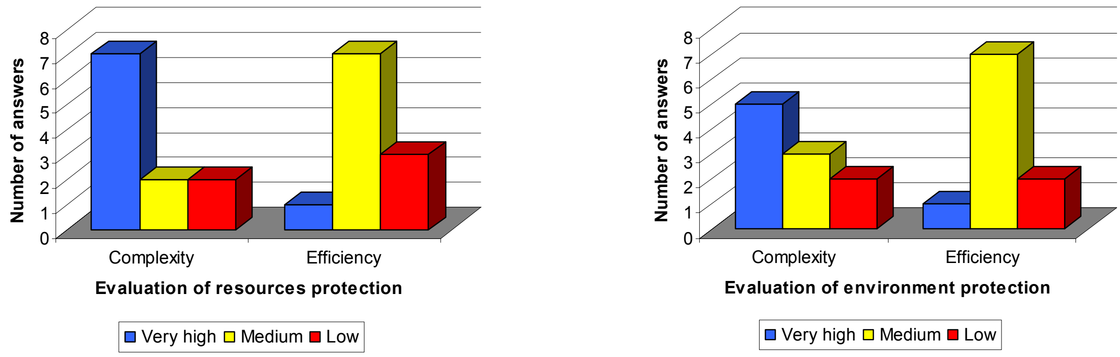


Figure 7. Evaluation of the complexity and efficiency of resources protection and environmental protection regulations for several APEC economies.

The position of the fishery authority within the government varies among economies (Figure 8). Nevertheless, Ministry (Secretary) or Sub-Ministry (Undersecretary) levels within the executive predominate, with (in some instances) a variety of midlevel bodies with counseling or executive capacities, where different components of the fishery sector can express themselves.

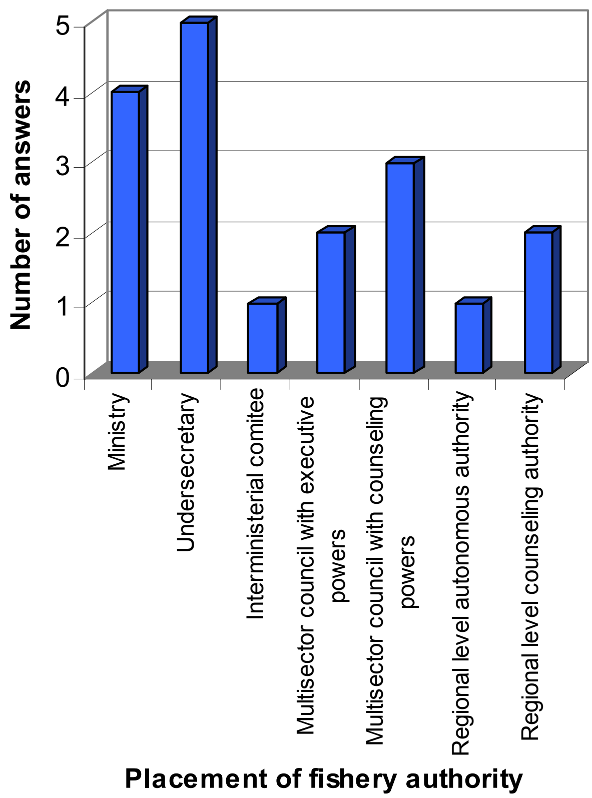


Figure 8. Position of the fishery authority in several APEC economies.

That is coherent with the importance our correspondents assign to different components of the fishery sector with regard to decision-making (Figure 9). Most of them rate central government components with a "very high" or "high". In some economies, particularly those with federal governments, they attach importance to local authorities. It is noteworthy that with the exception of the industry and, in some instances artisanal fishermen, no other organizations or stakeholders are rated important in the poll (universities, technical institutions, NGOs, national or local councils or committees), and we must assume that industrial or artisanal fishery representatives are part of the multi-sector councils named in Figure 8.

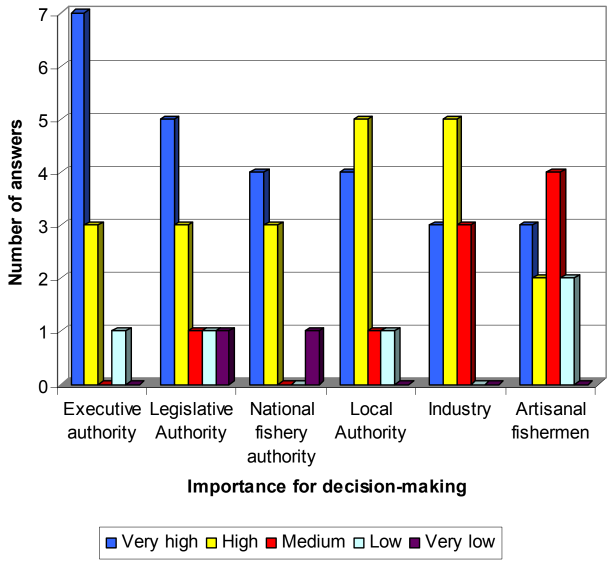


Figure 9. Importance of different sectors in decision-making for fisheries in several APEC economies.

Five out of the eleven correspondents claimed to have some knowledge of APEC's Political Agenda for the Marine Environment, while two indicated not to know about it (Figure 10). This level of knowledge can be considered poor, particularly when all those who answered the questionnaire are scientists closely linked to the fishery sector in their economies, and seem to imply a low level of dissemination of APEC policies among the economies.

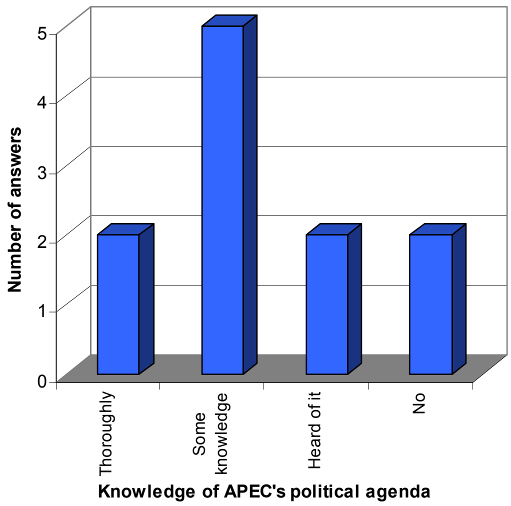


Figure 10. Knowledge of APEC's Political Agenda for the Marine Environment in several APEC economies.

Most of our correspondents claimed a thorough knowledge of ecosystem-based approach to fisheries management. In fact, none of them stated ignorance of EBA (Figure 11). This is important for the analysis of their answers to the query about application of EBA in their economies (Figure 12). Most of them indicate that EBA are applied to some fisheries, but at the same time say the application is largely conceptual, that is, there are policy statements about the political decision to implement this approach to fishery management (Figure 13). Also, they vary in their appreciation of the time scale for the operational application of EBA (Figure 14).

It must be noted that a minority of answers state that there is already operational application of EBA in some economies (Figure 13). In line with one of the facets of the discussion on what can be considered ecosystem based management, they present examples of

1. Area closures.
2. Environmental impact assessment for exporting fisheries.
3. Marine protected areas.

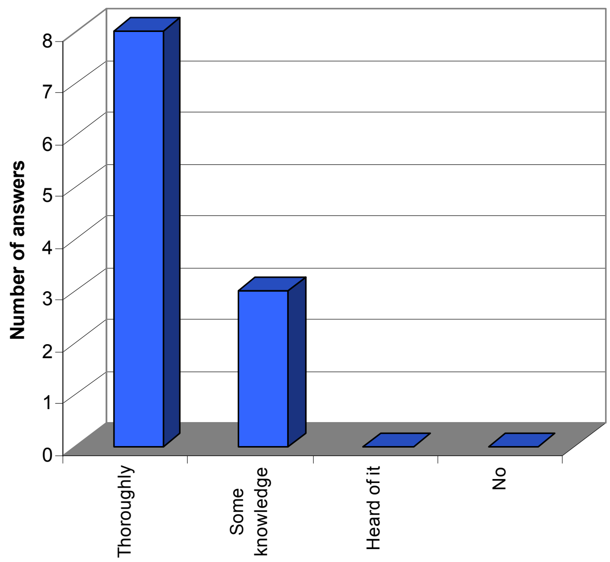


Figure 11. Knowledge of Ecosystem Based Approaches (EBA) to fishery management by correspondents in several APEC economies.

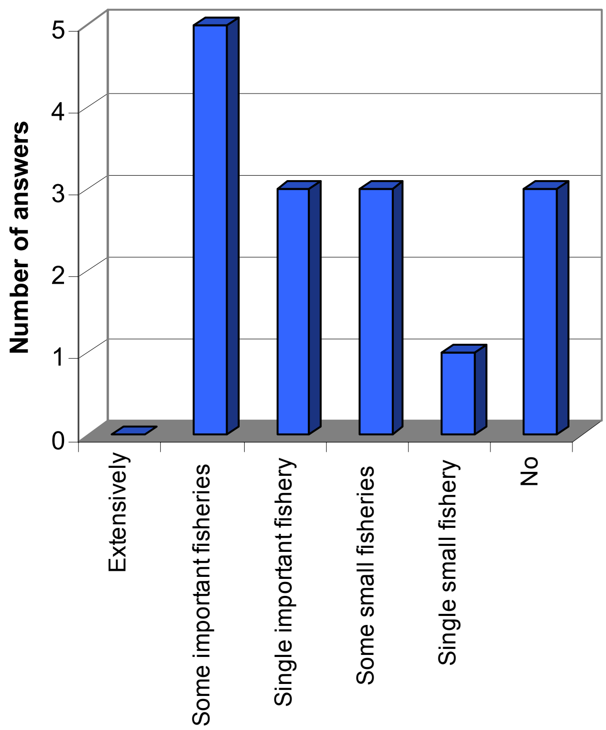


Figure 12. Application of Ecosystem Based Approaches (EBA) to fishery management in several APEC economies.

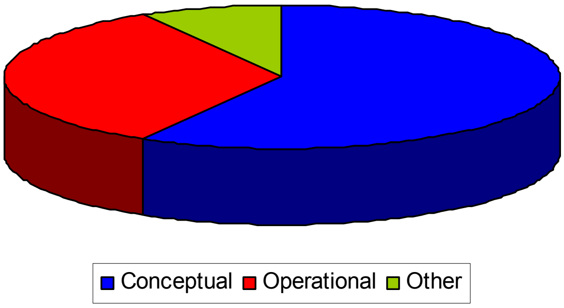


Figure 13. Type of Ecosystem Based Approaches (EBA) application to fishery management in APEC economies.

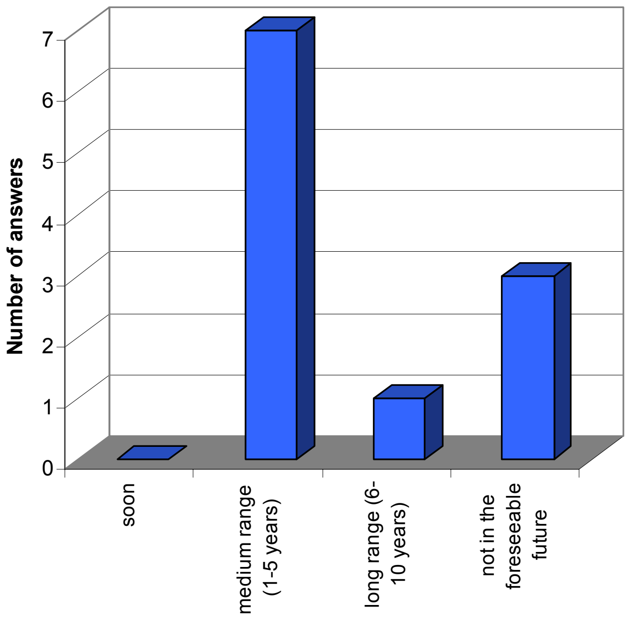


Figure 14. Time scale for Ecosystem Based Approaches (EBA) application to fishery management in several APEC economies.

Finally, we asked our correspondents to summarize the main problems and constraints they perceived for the implementation of EBA to fisheries in their economies. Their opinions (unedited) are in Table 1. Some of the important points they mention are:

a) insufficient knowledge of ecosystems;
b) single-stock management paradigm;
c) lack of technical and financial capacity;
d) fishermen's opposition;
e) local economy *vs.* global markets conflicts; and,
f) conservation *vs.* exploitation conflicts.

Table 1. Problems and constraints for the implementation of Ecosystem Based Approaches (EBA) to Fisheries Management in several APEC economies.

Main problems and constraints that I see are scientific and technical, i.e. how to delineate management areas (ecosystems), how to incorporate natural environmental variability, how to understand ecosystem structure and function sufficiently well to understand what "control levers" are available and how to use them. On the application side, our fisheries are generally single-species based, except for trawl fisheries. Attempts to manage trawl fisheries as multi-species assemblages have generally proved unsuccessful, because of different sensitivities to exploitation and stock strengths of the species involved.
Concept is not yet sufficiently understood by high authorities to take this info to normative (legislative) level. There are serious conflicts between exploitation and conservation.
Little bit over fishing.
Any fishery which wishes to export must be assessed to prove its sustainability The guidelines are under the EPBC Act, administered by the Department of Environment and Conservation (www.deh.gov.au)
Too few studies done on the fisheries, too little knowledge on the dynamics of fisheries resources, nothing on the ecology and biology of major species, migration routes, etc. The current fisheries statistics is not reliable and can not be used in decision making process.
a) information is gathered at a population level (or stock level); b) there is a strong sectoral view of the subjects, consequently a holistic approach it is difficult to be implemented; c) some researchers and professionals associated to gather the information or charged to take decisions, respectively, have not been trained to apply EBA; d) although some important fisheries are characterized not only from the population point of view, so other information is available, as physical environmental features or biological relationships (e.g. trophic relationships), but in general this data are available as part of a characterization of the environment where the fishery is located, but not always it is utilized to take decisions as part of a whole; a) multi-fishing gear; and, b) Conflicts among users
a) shared stock with adjacent counties; b) migrant resource fisheries; c) fishermen's opposition; d) low conservation concept; and, e) illegal fishing.
EBA can be applied more easily at the community or local levels. The Philippines has been using this approach. However, problems occur when the local economy is burdened by the global market. Small fishers are forced to compete and the environment and resources become over utilized.
The main problems and constraints are the absence of projects and funds for the implementation of EBA in fisheries in our economy.
Lack of technical and financial capacity and human resources. Theoretically, the current institutional arrangement can accommodate ecosystem-based management within and across the different local government units, but this requires much preparation and cooperation between the authorities concerned.

PART 2. ANALYSIS OF SOME FISHING LAWS FROM APEC ECONOMIES

2.1. Fisheries legislation and EBA in APEC economies

The application of ecosystem-based management in fisheries ought to be reflected in the legislation framework that regulates the utilization of living aquatic resources. To evaluate whether there is any formal application of EBA in APEC economies we gathered the information available in the web about fishery legislation. We decided to use primary sources. It means that the actual legal texts in effect in each economy, instead of published reviews or analysis to avoid any possible bias. It must be understood that we have not attempted a formal or technical law study since there are no lawyers in our team and it was not the scope of this project. Rather, we have tried to understand fishery legislation from the perspective of fishery scientists.

2.2. Limitations

The following restrictions have conditioned access to fishery legislation in APEC economies:

a) Availability in Internet: we have had access to legal documents pertaining to fisheries (laws, acts, bills, regulations et cetera) from 16 economies. The scope, depth and relevance of the information accessed are variable among economies. For example, for the Philippines we have only the main Fisheries Code, while for Canada, Australia and the USA we have been able to find the main legal framework for fisheries, lower level regulations, guidelines and other pertinent laws, such as those about environment protection. For another five economies we have found their fishery authorities homepages, but we have not been able to access their fishery laws, either because they are not available in the net or for language (for instance, Japanese language).

b) Language: our team is proficient in Spanish and English. Some economies do not have readily available fishery documents in these languages, thus limiting our access to them. For instance, we accessed Indonesia's fisheries law, but were unable to read it, and we know there are important legal documents in Russia's State Fishery Committee Homepage, but we do not understand Russian.

2.3. Information analyzed

Tables 2 and 3 enumerate the economies we have found information for, the characteristics of that information and some of the most important sources we have explored in the net. A link is provided at www.unitep.cl (Unidad de Tecnología Pesquera® of the Universidad de Concepción) to access the documents we gathered after the final report (January, 2006).

2.4. Analysis

The legal framework that regulates access to, and utilization of, aquatic resources is complex. In most economies there is a core of fishery regulations that delineate conditions for fishing or aquaculture, and the rights and obligations of stakeholders (and of the fishing authorities). But, there are complementary issues that must be taken into account for a broad view of each economy's fishery sector. Most economies have Maritime and/or Navigation Laws, that set the characteristics and conditions for fishery vessels to operate, and a variable fraction of control and surveillance is, in many cases, in the hands of naval or coast guard institutions and not wholly under the fishing authority. Production and trade are usually controlled or overseen by other branches of government and in several instances fishery statistics are gathered by independent Statistics Bureaus or Agencies. Health authorities and legislation play a part, too, since most resources are destined for human or animal consumption. Environmental Impact Assessment is gradually gaining importance in the legal structure of most economies, and some parts of the fishery sector come under the rules set for environment sustainability. Finally, all APEC economies are parts to legally-binding International Treaties, Conventions or Agreements related to fishery resources, endangered species protection, environment protection, international trade, etc. All these imply that stakeholders have to consider many different aspects in their activities and that there can be important cases of overlapping jurisdictions or (quite the opposite) gray areas not included in an economy's legislation.

Table 2. Summary of the most relevant information collected through internet about legal frameworks for fisheries in APEC economies.

Economy	Official language	Documents available in other language	Description
Australia	English	NO	General Fisheries Law Other fisheries' legislation Links to complementary issues
Brunei Darussalam		English	Department of Fisheries Homepage
Canada	English	YES	General Fisheries Law Other fisheries' legislation Links to complementary issues
Chile	Spanish	English (summary)	General Fisheries Law Other fisheries' legislation Links to complementary issues
Chinese Taipei	Chinese	English	General Fisheries Law
Hong Kong	Chinese, English	NO	Fisheries legislation (summary)
Indonesia	Indonesian	NO	General Fisheries Law Conservation Law
Japan	Japanese	English	General Fisheries Law Links to complementary issues
Malaysia	Malay	English	Department of Fisheries Homepage (in Malay)
Mexico	Spanish	NO	General Fisheries Law Other fisheries' legislation Links to complementary issues

Table 2. (continued)

New Zealand	English	NO	General Fisheries Law Other fisheries' legislation Links to complementary issues
Papua New Guinea	English	NO	General Fisheries Law Other fisheries' legislation Links to complementary issues
Peoples' Republic of China	Chinese	English	General Fisheries Law
Peru	Spanish	Spanish	General Fisheries Law Other fisheries' legislation Links to complementary issues
Philippines	English	YES	General Fisheries Law
Republic of Korea	Korean	English	Ministry of Maritime Affairs and Fisheries Homepage
Russian Federation	Russian	NO	State Fishery Committee Homepage
Singapore	English	YES	Fisheries Act
Thailand	Thai	English	Department of Fisheries Homepage
United States of America	English	YES	General Fisheries Law Other fisheries' legislation Links to complementary issues
Viet Nam	Vietnamese	English (summary)	Ministry of Fisheries Homepage

Table 3. Summary of the most relevant internet pages visited, where information about legal frameworks for fisheries in APEC Economies can be found.

Global sources	www.un.org/Depts/los/LEGISLATIONANDTREATIES/STATEFILES/SGP.htm www.worldfishcenter.org/ www.oceanlaw.net www.fao.org/ www.onefish.org www.intfish.net www.oceansatlas.org www.apec-oceans.org/ www.apfic.org www.oecd.org/dataoecd/
Australia	www.daff.gov.au/ www.afma.gov.au www.csiro.com.au www.deh.gov.au/coasts/fisheries/pubs/guidelines.pdf
Brunei Darussalam	www.fisheries.gov.bn/introduction.htm www.industry.gov.bn/
Canada	laws.justice.gc.ca www.dfo-mpo.gc.ca
Chile	www.subpesca.cl www.sernapesca.cl
Chinese Taipei	www.fa.gov.tw/english/
Hong Kong	www.afcd.gov.hk/fisheries/fish_e.htm
Indonesia	www.bkpm.go.id/en/law.php
Japan	www.maff.go.jp/eindex.html

Table 3. (continued)

Korea	www.momaf.go.kr/eng/main/main.asp
Malaysia	agrolink.moa.my/dof/newdof/index.htm
Mexico	www.bibliojuridica.org/libros/2/910
New Zealand	www.legislation.govt.nz/browse_vw.asp?content-set=pal_statutes
Papua New Guinea	www.fisheries.gov.pg
People's Republic of China	www.china.org.cn
Peru	www.produce.gob.pe/mipe/
Philippines	www.da.gov.ph www.bfar.da.gov.ph/
Russia	www.gkr.ru/
Singapore	agcvldb4.agc.gov.sg/
Thailand	www.fisheries.go.th/english/index.html
USA	www.nmfs.noaa.gov/ www.regulations.gov/fdmspublic-rel11/component/main
Viet Nam	www.mofi.gov.vn

Irrespective of the economic, social or cultural importance of fishing, all economies have developed a legal framework and an administrative structure to manage their fisheries. Also, even though there is a variety of governing systems in APEC economies (i.e. Federal-Presidential, Federal-Parliamentary, Centralized-Presidential, Communist, Constitutional Monarchy, etc.), all have established a central fisheries management agency within the executive branch.

The complexity of the general fishery management legislation (law, act, bill or code) differs among the economies. Nevertheless, most of them share the same basic structure, including scope, objectives, definitions, management procedures, monitoring, surveillance, enforcement and penalties. The differences are related mostly to the relative importance of different kinds of fisheries or aquaculture for each economy. There are, also, varying degrees of importance for fishery management assigned to various levels of territorial authorities, depending on the political-administrative system of the economy. Some economies favor centralized management, while others have independent fishery authorities at estate or regional levels, and the federal authority must negotiate with them joint management programs for specific fisheries. There are also intermediate conditions, where local authorities play important roles, but for restricted fisheries or local communities.

So far as we have been able to find, all fishery legislation in APEC economies are based either on the principle of common property (*res communis*), meaning that resources belong to the community, or the principle of no-owners (*res nullius*), meaning that resources belong to no one and become the property of the person that catches them. These legal principles and their impacts (economic, social, cultural and environmental) on fisheries have been widely discussed and are beyond the scope of this work. Through fishery legislation the economy assumes control of the resources and establishes access rules and conditions for use, with varying degrees of compulsory observance, exclusivity and trading or exchange rights. Most economies have systems to restrict or control access to specific fisheries using rights allocation; the mechanisms include

a) allocation by historic rights (level of use, landings, investments);
b) auctioning of fishing shares; and,
c) lottery or ballot approaches.

With the exceptions of Canada, who repealed the Purpose Section of its Fisheries Act, and Hong Kong whose "ordinance" is limited to forbid destructive fishing practices, all economies analyzed state in their general legislation that some of the following principles guide their management procedures:

a) optimum utilization and long term ecologically sustainable development of living resources;
b) maximizing economic efficiency in resource utilization; and,
c) application of a precautionary approach.

These objectives are generally approached through the paradigm of single-species assessments and management, and different levels of restrictions to fishing, depending on the conditions of each fishery (fully exploited, under exploited or, most commonly, over exploited).

All economies have control systems to regulate access and fishing effort. The input-based management techniques are common to all economies, and it includes:

a) characteristics of the gear and/or the vessels that can operate on a given resource;
b) minimum size of specimens;
c) time and area closures to protect spawning or juveniles, or to limit access to fishing grounds;
d) requirement of government-issued fishing licenses; and
e) recognition of traditional fishery rights to specific communities in coastal areas.

A minority of APEC economies have established output controls for management like these:

a) Fishing quotas from stock assessment estimates. These can take the form of Total Allowable Catch (TAC), free for all fishermen, or divided into Individual Quotas (IQ), non-transferable (i.e. Chile) or transferable (ITQ: Canada, USA, Australia, etc);
b) Total Allowable Effort (TAE: Japan); and,
c) Individual Transferible Effort (ITE: Canada, Australia, etc).

Generally, fishing activities are subjected to a variety of management control mechanisms that can combine both input and output types.

Historically, top-down management strategies have been applied to fisheries with the objective of regulating access to resources and fishing effort. Recognizing the costs (economic and political) involved in trying to control stakeholders without personal commitment to resource sustainability, fishery legislations in some economies have incorporated provisions for the participation of those agents in management decision-making. The importance of stakeholders in these co-management or cooperative management strategies varies among economies. In some cases, they have an important role, but in restricted small-scale coastal fisheries, like Japan, where there is tradition of co-management, with fishing rights for coastal and small-scale (artisanal) fisheries historically allocated to specific fishing communities. Also, co-management for some resources, particularly those important for artisanal fishermen, can be found in the fishery legislations of Chile, Korea, Mexico, Peru and the Philippines. In other instances, co-management has been established by the formal implementation of councils, committees or boards where different actors of the fishery sector can interact, with the stated objective of basing management decisions on scientific and economic analysis. The weight of these bodies is determined by many factors, such as how representative the members are, the degree of political authority granted by legislation, the relative economic, social or political leverage of the members, etc. They can be found at national or regional levels in the legislation of Australia, Canada, New Zealand, Chile, etc.

We have not found specific operational references to management under ecosystem-based approaches in the legal framework of the economies analyzed, even though there are Policy Statements to that effect in Australia, Canada and the USA. The Australian Government considers ITQ's as a basis for ecosystem-based management. The nearest approach can be seen in Canada and Australia, where the fishing authorities have issued general or species-specific guidelines whereby it is stated that fishing operations should be managed to minimize their impact on the structure, productivity, function and biological diversity of the ecosystem.

As stated elsewhere in this document, in the discussion of what constitutes ecosystem- based management some authors argue that area-closure strategies are components of EBA. Following this argument, it can be seen from the legal framework of APEC economies that most of them have mechanisms to implement area-based restrictions to fishing. Nevertheless, it must be considered that these regulations are applied usually to satisfy short-term objectives, such as protecting spawning areas during the reproductive season or protecting over-exploited beds of benthic organisms, like bivalve mollusks. As far as we have been able to investigate, these measures are applied within the framework of traditional, single-species fishery management.

Marine Protected Areas (MPAs) could be included in EBA management, and many APEC economies have established them, but it must be considered that most of them have not been created with fishery-oriented objectives and are not under fishery authority jurisdiction. Rather, they are the result of environmental conservation policies and their management goals are consistent with environment or ecosystem protection from human intervention. There is an exception in Chile's fishery law. In fact, it created the figure of Management and Exploitation Areas for Benthic Resources, which are assigned to artisanal fishermen, and established Marine Reserves to protect and manage areas important for the sustainability of fishing resources. Similar figure of this kind of MPA can be found in the Peruvian fishing law.

PART 3. ANALYSYS OF ECOSYSTEM-BASED APPROACH TO FISHERIES MANAGEMENT

3.1. An Overview

Shannon *et al*. (2004) communicated that a workshop was held in Cape Town in December 2002 to introduce the concept of an ecosystem approach to fisheries (EAF) management in the southern Benguela, and to examine options for implementing an EAF in South Africa, considering alternative modeling approaches that may have potential for an EAF. Consensus was that an EAF should be implemented through an incremental process. Ecosystem models can be used to provide guidance on reference points and broader management objectives still currently set on the basis of single-species management. Such additional information would be incorporated into the decision-making process, and comments received at a management level would also feed back to the modeling process. The approximation of Shannon *et al*. (2004) was selected in this report due to it is a typical exemplar process that could be implemented in developing countries.

3.1.1. Some modeling (and other) approaches of potential use in implementing an ecosystem approach to fisheries (EAF)

- Ecopath with Ecosim
- Individual-based modeling (IBM)
- Non-modelling ecosystem studies and approaches
- Comparing modeling approaches

Drawing from comparison of different modeling approaches by Fulton and Smith (2004), four issues were considered to by important (E. A. Fulton, CSIRO, Tasmania, pers. comm., in Shannon *et al*., 2004):

1. When developing ecosystem models, the taxonomic/functional groups of key interest should be identified, other useful groups should be aggregated as appropriate, and other less-useful groups should be omitted altogether.
2. As with all models, the trade-off between variance and bias needs to be considered.
3. The importance of modeling spatial aspects of fisheries and marine ecosystems has been widely recognized.
4. Hybrid modeling approaches, for example linking biomass size spectrum models and minimum realistic models, could assist in simulating key ecosystem driving forces and dynamics.

Butterworth and Plagányi (2002) noted that the effective usage of ecosystem models for decision-making are still a way off, but ecosystem models may play a useful role by simulating future resource trends to test how alternative candidate “decision” models may perform. In order to carry out operational management procedures (OMPs), those authors raise the following questions:

- In the OMP context, is the immediate role for multispecies/ecosystem models as testing or decision models?
- Do mass-balance constraints appreciable reduce uncertainty about current single-species management model estimates of abundance and productivity?
- What immediate relative emphasis should be placed on "Whole Ecosystem" *vs*. "Minimum Realistic Model" analyses (e.g. hake cannibalism/interspecies predation)?
- What is the most appropriate analytical platform for such exercises?
- What are the cost implications for data collection and analysis?

3.1.2. How to incorporate ecosystem considerations into fisheries management?

In relation to EAF, Shannon *et al*. (2004) proposed that the priorities, in terms of primary policy goals and high priority objectives, would be:

i. to rebuild depleted stocks;
ii. to take into account wider fisheries effects (e.g. bycatch issues); and,
iii. to make better use of the ecosystem, to reduce risk of irrecoverable resource damage and economic/social crises.

According to Shannon *et al*. (2004), EAF has a better chance than current single-species management approaches of achieving sustainable fisheries, because the aims for healthy ecosystems, which in turn should ensure optimal social end economic benefits. Management units should coincide with species distributions and boundaries.

3.1.3. Developing an EAF management procedure for the offshore fisheries

Concerning the role of ecosystem research, Shannon *et al*. (2004) declare that new insights may emerge from multispecies models without prior assumptions of particular theories. Ecosystem models could help quantify interactions that were previously only qualitatively defined, and may provide insight into process and mechanisms not discernible with single species only.

3.1.4. Implications of EAF for fisheries management

The local and regional regulations to fisheries, international agreements and conventions would need to take into account in implementing an EAF in a country or economy. An overarching management plan (OAMP) would have to be implemented in a stepwise, transparent fashion, and may need to prioritize the different fishery sectors.

According to Shannon *et al*. (2004), wide representation across stakeholder groups and ways to balance conflicting objectives will be required for the successful implementation of an EAF. Potential areas of conflict are numerous, and include:

- reduce quotas to fisheries in order to address ecosystem issues such the needs of predators;
- conflicts between consumptive and non-consumptive objectives and stakeholders;
- conflicts between different primary fishery sectors such as demersal and pelagic;
- conflicts between different groups of users within each primary sector, such as the handline and trawl sub-sectors;
- conflicts between mining and fishery stakeholders;
- conflicts between the aquaculture industry and, for example, capture fisheries;
- conflicts between the users causing marine environmental degradation and fishers; and,
- conflicts between new fisheries and existing ones.

A starting point would be the development of a draft EAF policy that includes inputs from all stakeholders and takes due consideration of relevant socio-economic factors.

3.2. An Ecosystm Approach to Fisheries (EAF)

Cochrane *et al*. (2004) declare that the 2001 Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem and the Plan of Implementation of the 2002 World Summit on Sustainable Development highlighted the need in fisheries to look beyond considering only the target species and to consider in fisheries management the impacts of fisheries on the ecosystem as a whole, as well as the impacts of the ecosystem on fisheries. All fisheries have impacts beyond the target species and that an ecosystem approach is required in order to ensure the long-term sustainability of the living marine resources of the ecosystem as a whole.

3.2.1. The Concept of EAF

According to Cochrane *et al*. (2004), the concept of an ecosystem approach to fisheries is not now, and it is likely that even the earliest human users of living marine resources has a reasonable understanding of the interrelationships and interdependence of the different components of the ecosystem from which they were extracting organisms. For instance, Mat *et al*. (1979) forecasted the increasing need for fisheries management to take species interactions in account. Currently, it is recognized that ecosystem effects need to be considered in management fisheries (Pauly, 1998; Gislason *et al*., 2000). Livingston and Tjelmeland (2000) suggested that it was particularly important that ecosystem considerations be incorporated into fisheries management in systems in which exploited fish stocks interact strongly with one another and are very important for sustaining top predators like marine mammals and seabirds. The Bering Sea is a example of an ecosystem for which good progress has been made towards ecosystem-based management, due to a precautionary approach to managing the Bering Sea groundfish fishery has been adopted, based on scientific research and advice, extensive monitoring, enforcement, bycatch controls, conservative quotas, conservation of habitat and the seasonal an spatial allocation of fishing (Whiterell, 1999 *fide* Shannon and Moloney, 2004).

Within the context of current attitudes and approaches to fisheries, there are some elements of an ecosystem approach contained in the United Nations Law of the Sea Convention of 1982. However, it could be argued that the real origins of an ecosystem approach to fisheries (EAF) can be found in Chapter 17 of Agenda 21 of the 1992 Rio Declaration on Environment and Development. The major phase of the development of the Code of Conduct for Responsible Fisheries by the Food and Agriculture Organization of the United Nations (FAO, 1995) happened shortly after the Rio Declaration, and almost all the major features and requirements of EAF can be found within the Code, even though it does not explicitly refer to EAF. By the end of the 1990s, nations such as Australia (Smith *et al*., 1999) and the USA (National Research Council, 1999) were actively moving towards an ecosystem orientation in their fisheries management. Moreover, the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) is a working example of a programme adopting ecosystem approaches to fisheries management. The ecosystem approach to management was defined by Larkin (1996) as "management of marine fisheries with awareness of ecosystem properties".

3.2.2. Reykjavík Conference on Responsible Fisheries in the Marine Ecosystem (2001)

In the Reykjavík Conference on Responsible Fisheries in the Marine Ecosystem, held in October 2001, the role and importance of EAF was recognized by 47 countries, which included a Declaration "… that, in an effort to reinforce responsible and sustainable fisheries in the marine ecosystem, we will individually and collectively work on incorporating ecosystem considerations into that management …" (FAO, 2001). This Declaration was recognized and reinforced at the World Summit for Sustainable Development in Johannesburg in 2002. The Plan of Implementation of this Summit included the exhortation to "Encourage the application by 2010 of the ecosystem approach, noting the Reykjavík Conference on Responsible Fisheries in the Marine Ecosystem and decision 5/6 of the Conference of Parties to the Convention on Biological Diversity" (http://www.johannesburgsummit.org/html/documents/summit_docs/2309_planfinal.htm).

Cochrane *et al*. (2004) declare that there is an international pressure on all fishing nations to begin to implement an ecosystem approach in their domestic fisheries and in any international fisheries in which they participate. As with the Code of Conduct, implementation is likely to be slow, and many countries, agencies and individuals are still grappling with interpreting just what is intended by the term EAF (FAO, 2003).

3.2.3. Ecosystem Approach to Fisheries (EAF): Clearing the Mist

Several interpretations of EAF have been quoted. For instance, Lackey (1999 *fide* Cochrane, 2004) defined that "Ecosystem management defines a paradigm that weaves biophysical and social threads into tapestry, health and sustainability". But, this kind of quotation does little to help to policy-maker. According to Cochrane *et al*. (2004), the ideal of an ecosystem approach is summarized by Chapter 17 of Agenda 21: "The marine environment –including the oceans and all seas and adjacent coastal areas– form an integrated whole that is an essential component of the global life-support system and a positive asset that presents opportunities for sustainable development. International law … sets forth rights and obligations of States and provides the international basis upon which to pursue the protection and sustainable development of the marine and coastal environment and its resources.” Other attempts have been done to translate this ideal into a practical and feasible approach, including those of the National Research Council of the United States of America (1999), the Convention of Biological Diversity (Decision V/6 of the Conference of the Parties, 2000), and the World Wide Fund for Nature (Ward *et al*., 2002 fide Cochrane *et al*., 2004).

In FAO (2003) can be found an interpretation consisting in the following rationale and definition of EAF, which should be read and interpreted together:

- **Rationale**. The purpose of an ecosystem approach to fisheries is to plan, develop and manage fisheries in a manner that address the multiplicity of societal needs and desires, without jeopardizing the options for future generations to benefit from the full range of goods and services provided by marine ecosystems.

- **Definition**. An Ecosystem Approach to Fisheries strives the balance diverse societal objectives, by taking account of the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach to fisheries within ecologically meaningful boundaries.

Moreover, the Convention on Biological Diversity provided a set of 12 principles for an ecosystem approach (Annex 2), whereas the FAO Guidelines provide a list of principles focused on an ecosystem approach to fisheries management (Annex 3). The last one attempts to take a practical and pragmatic approach to implementing EAF, emphasizing evolution of EAF rather than revolution. The FAO Guidelines focus on process, steps and tasks involved in an EAF, although management objectives, management measures, capacity of the management agency, and the nature of fisheries will vary considerably from case to case, from economy to economy. Annex 4 presents the major headings and subheadings of the FAO Guidelines of EAF.

According to Cochrane *et al*. (2004), the FAO Guidelines recognize that an incremental approach will usually have to be followed, and stat “EAF is neither inconsistent with nor a replacement for current fisheries management approaches …, and is likely to be adopted as an incremental extension of current fisheries management approaches” (FAO, 2003).

3.2.4. An overview of the FAO (2003) recommendations on implementing EAF

In advising how to develop operational objectives from policy goals, the EAF Guidelines (FAO, 2003) draw on the model used for national reporting on the implementation of ecologically sustainable development for capture fisheries in Australia (Flechter *et al*., 2002 *fide* Cochrane *et al*., 2004). That model would have been successfully used in Australian federal fisheries to involve the major stakeholders in identifying and prioritizing the key issues in each fishery, where the “fishery” is clearly defined by the management agency. The process is simple and, working from a “generic component tree” that covers the range of issues relevant to fisheries, in general, the set of stakeholders is required to work down from the high level policy goals, elaborating more and more detailed issues under each goal, until they reach a level of specificity that the management agency can identify (Figure 15). For each specific issue, it should be possible identify an appropriate operational objective related to it, and then to define indicators and reference points reflecting the operational objective. Emphasis on EAF will require the inclusion of a wider range of ecosystem policy goals in the final operational objectives and therefore also require involving the full range of stakeholders in setting those objectives.

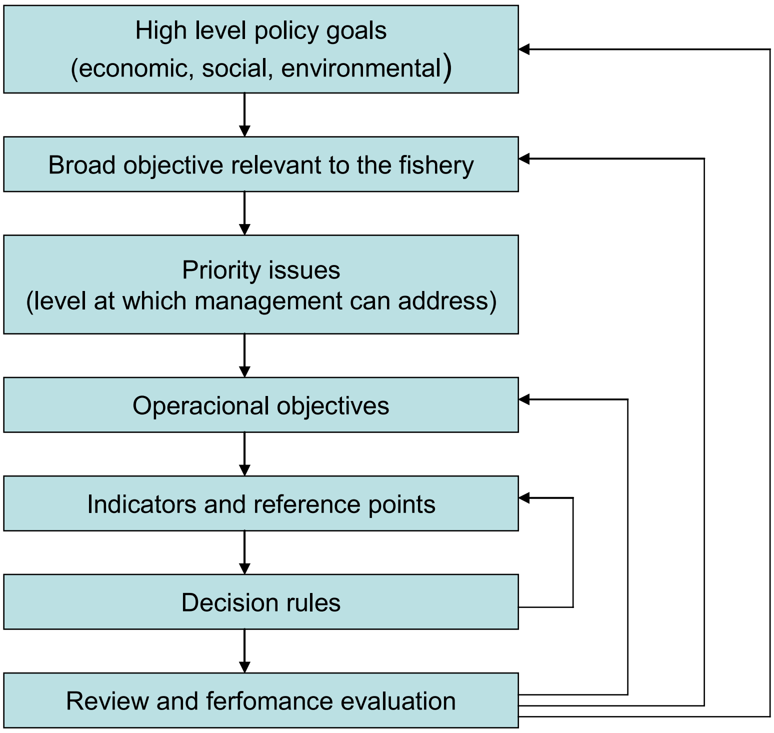


Figure 15. From policy to action (after FAO, 2003)

3.2.5. Management measures and approaches

According to Cochrane *et al*. (2004), fisheries management agencies have to relay a large extent on the same old and tested techniques that have both succeeded and failed over the decades of target-resource orientated management. EAF will require that the application of management measures considers and allows for the broader goals of the approach, and this will require wider thinking, greater synergy between measures and, in all probability, more conservative or precautionary application of fishing methods than has usually been the case in the past.

3.2.6. Ecosystem manipulation

EAF puts a greater emphasis on the interactions between the fishery, the target resources and the rest of the ecosystem. But, EAF does not mean that man will manipulate the whole ecosystem. This idea will be explained in detail in the last draft of this report.

3.2.7. Ecosystem research: the sum of all the parts and emergent properties

According to Moloney *et al*. (2004), one approach to studying ecosystems requires measurement of as many components as possible over time and space. The underlying basis of this approach is that an ecosystem functions as the sum of all of its individual parts. Taken to extremes, this approach is logistically impossible. In fact, no one can measure everything, everywhere, all of the time. However, to understand ecosystem dynamics, it is necessary to have a comprehensive research programme that involves studies of all trophic levels.

According to Moloney *et al*. (2004), a second approach to studying ecosystems assumes that they have properties that result from the totally of their interacting components. It is therefore not possible to predict or understand the ecosystem merely by studying all its parts. Rather, it is necessary to study integrated aspects of its structure and function. For instance, for the southern Benguela ecosystem, Moloney *et al*. (2004) declare that, in order to understand the integrated flows within the ecosystem, studies of diets and associated trophic roles were expanded to include a wide range of predators, and that many of the important feeding interactions in that ecosystem were quantified, including mass balance calculations to estimate the roles of different groups as predators and prey. These authors declare that the use of ECOSIM and ECOPATH models (Christensen and Walters, 2000) provide insights into the ecological effects of harvesting forage species and some top predators, such as seals and dolphins. These kinds of models can help to understand key interactions within the ecosystem. For instance, Neira and Arancibia (2004) applied this kind of model to the central Chile marine ecosystem with an ecotrophic multispecific approach.

Ecosystem-based research can be used explicitly in fishery management. For instance, Moloney *et al*. (2004) inform that it was used in management of South Africa pelagic fishery, and such research has contributed substantially to increased understanding of the pelagic ecosystem and the role and position in the ecosystem of the major pelagic species (Cury *et al*., 2000). According to Moloney *at al*. (2004), ecosystem studies provide the context within which management decisions can be made, and such studies are needed to formulate and communicate long-term objectives effectively to all stakeholders. It means that this contextual framework has been useful both to fishery managers and the industry.

3.2.8. Rights-based management approaches

According to Cochrane *et al*. (2004), in recent decades the long-standing tradition of open access to marine resources has been discredited, and rapid progress have been made in limiting access to fishery resources, so avoiding the classical problem of the "tragedy of commons" (Hardin, 1968). A system of access rights appropriate for the ecology, social and economic context of a fishery is an important precondition for obtaining the optimal benefits from that fishery. There is a range of options for use rights (Charles, 2002), including customary marine tenure and territorial use rights in fishing, limited entry (an input control), and quota allocations (an output control). Implementation of EAF could require changes in allocations to address, for example, interactions between two fisheries.

3.2.9. Creating incentives for EAF

Cochrane (2000) pointed out that two institutional features of traditional fisheries management have been widely considered to have been important in the common failure of fisheries around the world: (i) the prevalence of open access fisheries, and (ii) an almost ubiquitous reliance on centralized and top-down approaches to management.

In addition to the incentives achieved through acceptable of user rights and co-management, the short-term impacts, on fisheries in particular, of implementing EAF will frequently require the consideration and use of other incentives that can play a role in encouraging stakeholders to accept and adhere to the requirements of the approach. Some possible areas for creating better incentives are (FAO, 2003):

- improvements of the institutional framework (including better management, research and compliance);
- developing collective values for sustainable use through education, training and dissemination of information;
- implementation of non-market incentives such as through taxes or subsidies;
- the creation of market incentives such as ecolabelling and the implementation of tradable property or access rights that provide an incentive to the owner to ensure that the value of the right does not fall through overexploitation.

3.2.10. Developing a management plan

The FAO Guidelines (FAO, 2003) emphasize the importance of the cycle planning, implementation and review (Fig. 16). The planning phase for establishing a management plan for EAF includes two main tasks: (i) consideration of and agreement on a set of feasible and compatible operational objectives based on relevant high-level policy goals; and (ii) the formulation of management strategies consisting of a set of management measures to achieve the operational objectives. The management process typically includes good scientific advice and input, although not always complete, participation by stakeholders in decision-making, reasonable effective control, and generally good levels of compliance.

Cochrane *et al*. (2004) emphasize that once the operational objectives have been reconciled, it is necessary to develop management rules or strategies that will achieve those objectives. In practice, the two steps tend to be iterative, because the operational objectives may well need to be redefined as the performance of different management strategies is considered. Those authors declare that the recommended approach for developing strategies is based on that used in operational management procedures (OMPs).

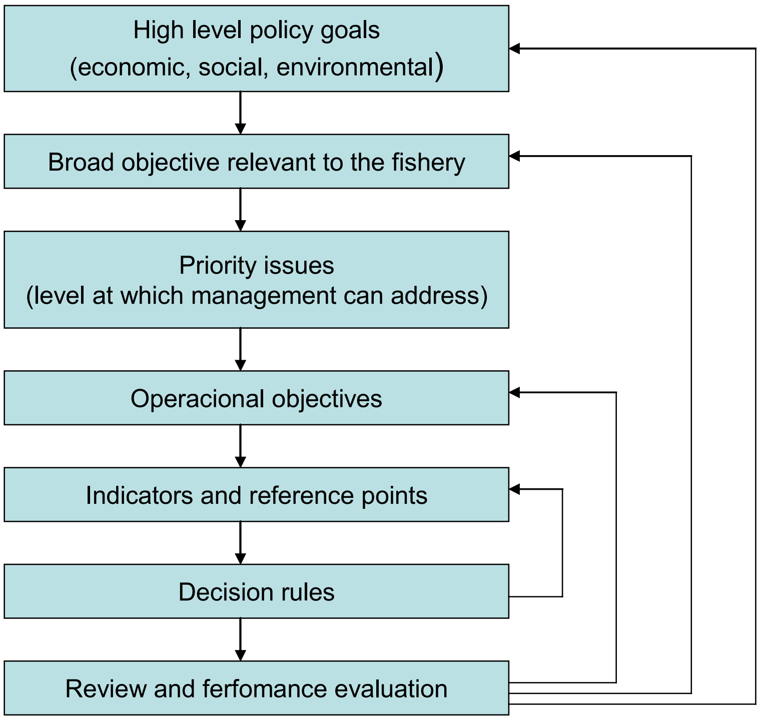


Figure 16. Developing management plan (after FAO, 2003)

3.3. The Need for EAF

In order to implement EAF in an economy, Cochrane *et al*. (2004) declare that the first task for the management agency in consultation with the range of stakeholders in fisheries is to identify the primary problems, issues and needs related to EAF within the existing management strategies for the different fisheries and the other impacting activities. Thereafter, key, feasible objectives will need to be developed. Once these objectives have been agreed, it will be necessary to prioritize them, taking due account of their ecological and socio-economic importance and potential benefits, and the costs of implementing the necessary changes. The review of prioritized objectives would also indicate which objectives could be addressed in the short-term, with available knowledge and resources, and which will require greater knowledge and capacity before they can be addressed. In accordance with the Code of Conduct, "… the absence of scientific information should not be use as a reason for postponing or failing to take conservation and management measures (FAO, 1995).

3.3.1. Threats to implementation of EAF

Cochrane *et al*. (2004) declare that throughout the world, stakeholders and governments are struggling to improve their management and utilization o living marine resources, so as to ensure that optimal benefits can be obtained from them in a sustainable manner. The implementation of EAF will make additional demands on already stretched political and social will, capacity and resources. Success in implementation is by no means guarantee. Moreover, there is also skepticism, or caution, about the immediate need for EAF, and its implications for management of the high priority target species. But, the greatest threat to successful implementation of AEF will be the problems associated with reconciling the conflicting demands of different stakeholders. FAO (2003) suggested that, in some cases, differences will not be reconcilable, and high level intervention will be required to make the final decisions. However, Cochrane *et al*. (2004) pointed out that the conflicts can only be resolved, if at all, through effective consultation and participation of different groups with some, several or many interests to exploit a fishing resource, a target species.

3.3.2. Proposal of a framework for an ecosystem approach to fisheries management

In this project, the ecosystem framework for fisheries management proposed by Shannon and Moloney (2004) for the Southern Benguela upwelling system has been selected. We guess this model is an excellent example to follow by developing economies specially. It is a "four-step framework" and it includes:

- first, static ecosystem models to highlight important interactions by assessing the net trophic impacts of each species on all the others;
- second, a dynamic simulation approach, indicators quantifying interactions strength and functional impacts to provide information on the size of impacts on ecosystem components when a fishing resource is overfished;
- third, dynamic simulations to suggest some possible short- and long-term ecosystem effects of altered fishing under strategies developed and selected using standard single-species models; and
- fourth, to take into account the net combined ecosystem effects of the revised strategies for all fisheries in the ecosystem.

3.3.3. A four-step procedure to manage fisheries in an ecosystem context

(after Shannon and Moloney, 2004)

Management of fisheries is usually applied within a specific legal and policy framework. Ecosystem approach to fisheries management should be subject to similar procedures as those applied to single-species fisheries management (Christensen, 1966). In other words, the stated goals must be incorporated into the fishing law of each country/economy. Shannon and Moloney (2004) proposed the following four-step framework for planning research activities to implement ecosystem approaches to fisheries management, due to what is currently lacking is a process for implementing policy objectives, and a plan to inform the implementation process through appropriate research and monitoring activities.

Step 1

To construct a trophic ecosystem model and to examine the interactions among species groups implied by the ecosystem structure. In standard fisheries stock assessment models, this would be equivalent to gathering biological data on the species to be modeled. This step, to identify the positive and negative interactions between species groups (the so-called mixed trophic impacts from the balanced model) from static ecosystem models, allows the construction of working hypothesis and highlights effects to be considered when applying a dynamic modeling approach (Steps 2-4). Some static ecosystem models for marine ecosystems have been publish using the Ecopath with Ecosim approach (Christensen and Walters, 2004), e.g. Sánchez and Olaso (2004) for the Cantabrian Sea, Heymans *et al*. (2004) for the northern Benguela, Neira and Arancibia (2004) for central Chile, Gasalla *et al*. (2004) for southern Brazil, Arreguín-Sánchez *et al*. (2004) for Baja California Sur in Mexico, Arreguín-Sánchez *et al*. (2004) for the southwestern Gulf of Mexico, and so on.

Step 2

According to Shannon and Moloney (2004), dynamic ecosystems models should be use to explore and quantify the interactions among species groups and to develop further understanding of how food webs function. This step is equivalent to applying a single-species population model (preferably a suit of models) to better understand the dynamics of the population. Ecosystem indicators should be developed that quantify species interactions, and that can be used to compare ecosystem dynamics in different situations. This would be analogous to producing reference points and thresholds (e.g. Maximum Sustainable Yield) in single-species models (Garcia and Staples, 2000). Shannon and Moloney (2004) used ECOSIM models to develop indicators derived from theoretical simulations of intense overfishing in a fishing resource. Such ecosystem indicators can indicate how strongly the ecosystem might respond to altered fishing on different fish stocks. They can also give added support to existing hypothesis, or indicate caution when results are contradictory.

Step 3

According to Shannon and Moloney (2004), dynamic ecosystem models should be used to conduct simulated fishing trials to test the ecosystem effects of fishing under various fishing scenarios. This step is equivalent to project a single-species population model into the future, under different catch scenarios, i.e. fishing mortality. Altered fishing scenarios do not necessarily involve overexploitation. However, the persistence of any changes in the ecosystem and the resilience of the model ecosystem to perturbation caused by fishing should be investigated. Possible undesirable short- and long-term effects can be identified using dynamic simulation models, and scientists, managers and decision-makers should be alerted to such risks. According to Christensen and Walters (2000), one of the advantages of ecosystem models is that they can assist in directing research by identifying data and information gaps. Based on such insights, it might be necessary to suggest changes to sampling programmes in order to monitor changes in ecosystem structure and functioning (Arancibia and Neira, 2005).

Step 4

Shannon and Moleney (2004) proposed that a synthesis should be conducted, whereby the ecosystem effects of an altered fishing strategy are considered for all fisheries in an ecosystem, so that the net effect can be quantifying. There is no real analog to Step 4 in single-species management.

3.3.4. Future development of a management procedure for ecosystems

According to Shannon and Moloney (2004), to carry out Steps 3 and 4 effectively, the underlying fisheries management objectives need to be known and clearly formulated. It is likely that developing explicit ecosystem-based management objectives will be an iterative process that involves refinement using Steps 3 and 4. These authors declared that the four-step framework could be extended further to punt into place a formal management procedure (MP) for ecosystems. An MP is a set of rules, pre-agreed by scientists, industry, managers and decision-makers and their advisers, to use fishery data to regulate fisheries, e.g. by setting annual TACs. The idea is that, once an MP is adopted for a fishing resource, it should be allowed to run its course for a period of 3-5 years before being extensively reviewed and modified (Cochrane *et al.*, 1998). This differs from conventional fishery management procedures requiring review and incorporation of updated data on an annual basis. Taking into account the suggestion of Shannon and Moloney (2004) given for southern Benguela ecosystem, the proposed four-step could be used as a part of an MP in which all the important components of a marine ecosystem (all fisheries, as well as resources that are important for non-consumptive exploitation) are considered simultaneously. Once an ecosystem MP is agreed, it should be allowed ideally to function for a period of 5-10 years before being reviewed and modified according to revised management objectives. Ecosystem models and analyses should be updated continuously.

Shannon and Moloney (2004) declare that objectives in a MP must be carefully defined for each fishery and for each non-consumptively exploited fishing resource when undertaking Step 3. It is essential that the overall objectives for fisheries and non-consumptive exploitation of the ecosystem are negotiated before undertaking Step 4. And, it is suggested that all stakeholders be involved in formulating and refining the management objectives.

Roux and Shannon (2004), in their paper about EAF in the northern Benguela, address the following important questions to take into account for simulations:

- Given the present structure of the ecosystem, what is the potential for recovery the historical levels of the main depleted stocks by altering the fishing strategy on those stocks?

- What is the potential strength of competitive interactions between stocks, and how would a target stock be affected by altered fishing strategies on potential competitors?
- What trophic effects would alter fishing on predators or preys of a given stock have on its trajectory, as well as on the rest of the system?
- What are the interactions between the different fisheries?
- What are the implications an ecosystem approach in the ecosystem under study?

Moreover, Roux and Shannon (2004) declare several important ecosystem issues to be addressed, which are not formally considered in management decision at present:

- effect of fishing bon non-target components of the ecosystem;
- interactions between different fisheries;
- changes in ecosystem state (regime shifts, competition between small pelagic fish species);
- species of conservation concern;
- biodiversity issues;
- impact of opening new fisheries (or closing fisheries) on the system;
- protected areas, including fishing restriction zones.

In relation to distribution of different fishing resources, Shin *et al*. (2004) take into account the spatial component using maps to analyze the spatial distribution because spatial co-occurrence determines potential interactions between predatory fish and prey of suitable size. They compare two models in order to identify the range of possible trajectories for the system dynamics. The models used are OSMOSE (Shin and Cury, 2001) and ECOPATH with ECOSIM, which has been applied for the same ecosystem by Shannon *et al*. (2003). Moreover, Pecquerie *et al*. (2004) declare that there is need for accurate and quantitative information on the geographical distribution of marine species to improve the modelling of the ecosystem and therefore its understanding. It becomes obvious when considering that the spatial and temporal distribution of trophically interacting species do not always coincide (Drapeau *et al*., 2004).

3.4. Review of Indicators in Fisheries Management. A Development Perspective.

I was selected the work of Degnbol and Jarre (2004), who reviewed indicators for an ecosystem approach to fisheries management, focusing on multispecies fisheries and limited resources for assessments and implementation, as often is the case in developing economies. It is addressed that other initiatives, like PICES, have been also discussing from some years ago about how to implement EAF in their economies. PICES includes five developed economies (USA, Canada, Russia, Japan and Republic of Korea).

According to Degnbol and Jarre (2004), in industrialized countries (economies), fisheries management is for the most part based on what can be called the "modern fisheries management model", in which mandated research within specialized institutions produces formalized knowledge, which is then used as a basis for management decisions and implementation by a centralized bureaucracy in interaction with representative democratic institutions. The implementation of management within this rationality is entirely linked to an assumption of predictability, which is an understanding that specific and predictable targets can be achieved by implementing regulatory measures such as catch or effort quotas, or technical measures. But, this kind of model for establishing a knowledge base for fisheries management has had limited success in both industrialized and developing countries. One of the most recent examples is the failure in the management of the nine stocks of cod (*Gadus morhua*) in the northern Atlantic Ocean, which are all heavy overexploited. Then, in words of Degnbol and Jarre (2004), there is need for new approaches in fisheries management, which are cost efficient, provide knowledge considered valid by stakeholders, and which are able to deliver.

The proposal of Degnbol and Jarre (2004), selected here, to investigate options for a knowledge base for fisheries management is focused on the situation in developing economies, although similar considerations could be relevant in industrialized economies. The development context is assumed to be characterized by mixed fisheries and limited resources available for observation and management implementation.

3.4.1. Widening the scope of sustainability from single target species to ecosystems: the need for indicators

Increasingly, the emphasis is on the need to consider fisheries sustainability in relation to the entire ecosystem, not only in relation to the stock (Sinclair and Valdimarsson, 2003). This implies a corresponding extension of the scope of the knowledge base for fisheries management, from the single stock being the unit and yield sustainability the main concern, to the ecosystem being the unit and the maintenance of system integrity the main management concern. In this approach, the "hard predictability" that has been the basis for the modern fisheries management model is replaced by a management system based on "soft predictability", which does not require detailed understanding of the processes and capability of quantitative predictions of outcomes of specific policies (Degnbol, 2002 *fide* Degnbol and Jarre, 2004). The knowledge base for management becomes indicators and qualitative predictions, rather than quantitative predictions based on process models. Recognition to these problems has created the basis for a rapidly emerging discussion on indicators for fisheries management and Ecological Qualitative Objectives in relation to fisheries.

3.4.2. Indicators in the management context

Indicators for fisheries management are a means to an end, *a priori* defined system characteristics that can provide feedback on progress towards management goals and objectives (Slocombe, 1999 *fide* Degnbol and Jarre, 2004). The primary consideration is the management objectives. Indicators must relate to the objectives by providing information on the state relative to the specific objectives for management and the direction to move to achieve those objectives. Second, the institutional set-up for management has important implications for the choice of indicators. If the management institution is based in a short-term decision horizon requiring hard predictions (e.g. the TAC system), one type of indicators will be required, whereas an adaptive management system will require indicators with different characteristics. Indicators must be accepted as valid characteristics by at least a sufficiently powerful subset of all stakeholders to be used as the basis for the management decision taken. However, acceptance is not trivial issue. But, the rationality of modern fisheries management requires the knowledge base for management decisions to be firmly rooted in what is considered to be scientific objectivity as the first priority.

3.4.3. Fisheries sustainability indicators

- Indicator concepts

According to Degnbol and Jarre (2004), the development of the concept of indicators in relation to fisheries sustainability has taken place within two different agendas. The first one are requirements of international ("horizontal") indicators. They should be observable on a comparable, standardized basis across a multitude of ecological and social systems, be based on internationally accepted research and relate to the objectives set out in the relevant agreements and codes. Acceptance among international decision-makers is important, whereas local acceptance by users may have less priority.

The second agenda relates to the need to develop a basis of knowledge that can guide practical fisheries management in the local context. Practical management decisions should be guided by knowledge of the present state of the specific fisheries and resource system. The emphasis is on the "vertical" use of knowledge within the fisheries system rather than horizontal comparability across systems. The main emphasis in this case of local/regional ("vertical") indicators is acceptance by stakeholders within all levels of the local/regional management system. There is no reason to expect that indicators developed within the "horizontal" and the "vertical" contexts will coincide. Focus about indicators will be on the local (vertical) management context.

- Types of indicators

According to Smeet and Waterings (1999 *fide* Degnbol and Jarre, 2004), the following four main classes of indicators can be distinguished:

- Descriptive indicators: they reflect an actual situation in a given system.
- Performance indicators: they compare actual conditions with a specific set of reference conditions, i.e. they measure the distances between the current and the target situation.
- Efficiency indicators: they relate environmental pressure to human activities and are therefore most relevant for decision-making.
- Total welfare indicators: they measure overall sustainability.

3.5. Criteria for evaluation of indicators

Ward (2000) quotes a set of criteria for sustainability indicators to fisheries used by Australian authorities in relation to marine ecosystem management. Degnbol and Jarre (2004) pointed out that fishery sustainability indicators should be:

➻ Related to management
- they should relate to specific management objectives;
- they should response to management measures within a reasonable time frame;
- they should be relevant to the scale of management (local, national, regional, international);
- they need to be compatible with management institutions.

➻ Acceptable
- by all stakeholders in fishery systems;
- by the public at large;
- they should be understandable in terms of having research-based substance and reflecting analytical soundness;
- they should be understandable in terms of reflecting features in accordance with stakeholders' understanding of the resource system.

➻ Observable
- with economic resources for research on a sustained basis;
- by stakeholders, either directly or by transparency in the observation process.

3.6. Candidate Indicators

According to Degnbol and Jarre (2004), indicators currently used in fisheries management refer generally to single fish stocks and focus on the sustainability of the resource base for the fisheries in this limited sense, and indicators referring to habitats, ecosystems or even integrating biological and societal issues area in the process of being identified, and have been used as a basis for actual management in few cases. But, we guess that the use of EAF in the near future likely depends more from political decisions than scientific knowledge to fisheries management.

Degnbol and Jarre (2004) declare that the focus of fisheries management is on situations with limited knowledge of the resource base, and limited economic resources for research, then indicators selected and discussed area those that showed at least some perspective relative to criteria of (1) acceptability to stakeholders, (2) observability and (3) relation to management. Each of these three criteria is subdivided into several scoring properties (Table 4). The relevance of each indicator for each property is evaluated with a simple numerical system similar to a traffic-light approach.

Table 4. List of criteria and scoring properties.

Criterion	Scoring property
1. Acceptability for stakeholders	1.1. Sustainability for communication among stakeholders
	1.2. Reflecting features in accordance with stakeholder's perceptions
	1.3. Data-based substance
	1.4. Clarity (unambiguity) of analytical results
	1.5. Transparency of the observation process to stakeholders
2. Observability	2.1. Resources requirements: skilled personnel
	2.2. Resources requirements: financial
	2.3. Time-series of indicator required for management directions?
3. Relation to fisheries management	3.1. Indicator responding to management actions in spite of environmental fluctuations?
	3.2. Management action and response closely linked in time?
	3.3. Institutional requirements
	3.4. Usefulness for large-scale management
	3.5. Usefulness for local management
	3.6. Reference points developed? (additional item, not included in the scoring)

Degnbol and Jarre (2004) pointed out that the linkage to management objectives is the overriding consideration. The indicators are therefore grouped into categories according to their linkage to specific objectives, whether they relate to objectives regarding the immediate resource base or to wider ecosystem considerations. There are therefore two main categories, the first relating to the immediate resource base, i.e. the target species, and the second to the resource system, i.e. the part of the ecosystem linked to exploited species. Within the first category, Degnbol and Jarre (2004) differentiate between single population indicators (Table 5) and indicators of the total resource base ("multispecies indicators", Table 6). Within the second category, these authors divide between habitat-related, environmental indicators (Table 7) and indicators of the biological production base (i.e. the wider ecosystem, Table 8).

Table 5. List of indicators describing single stock/populations targeted by the fishery.

Number	Indicator	Type
1.1	Consumption of local fish per person: amount and species composition	P
1.2	Number of permits issued for legal collecting and harvesting; fleet capacity	P
1.3	Descriptions of human fishing population: size, distribution, density	P
1.4	Age or length of specimens at first capture	P
1.5	Human fishing population: rate of change in density	P
1.6	Total catch (by stock and by area)	P
1.7	Exerted effort	P
1.8	Fishing intensity (effort/area)	P
1.9	Ratio of number collected to total size of reproducing population	P
1.10	Fishing mortality	P
1.11	Total catch/sustainable yield for modeled stocks	P
1.12	Average weight in catch, maximum length in catch	S
1.13	Maximum length (full geographic distribution of stock)	S
1.14	Catch per unit effort (cpue)	S
1.15	Disease/parasite prevalence in catch	S
1.16	Size distribution in stock (full geographic distribution)	S
1.17	Distribution area	S
1.18	Simple measure of stock size: biomass, abundance	S
1.19	Survey indices: cpue, length/age distribution, recruitment indices	S
1.20	Number of mature individuals in catch	S
1.21	Stock diversity of target species	S
1.22	School size of pelagic species	S
1.23	Ratio of current biomass to target biomass	S
1.24	Genetic diversity of target stocks	S
1.25	MSY-related estimates: MSY, Y/R, surplus production	S
1.26	Total production	S

P: social pressure; S: ecosystem state

Table 6. List of indicators describing the fishery production base ("multispecies indicators")

Number	Indicator	Type
2.1	Fishing population	P
2.2	Total effort exerted	P
2.3	Total catch (retained + discarded), ratio bycatch/catch	P
2.4	Amount of bycatch	P
2.5	Ratio discard/catch, ratio discard/bycatch	P
2.6	Unintended mortality (e.g. through dynamite) quantity	P
2.7	Mortality (quantity) of endangered or protected species	P
2.8	Bycatch mortality rate	P
2.9	Fishing-in-balance index	P
2.10	Unintended mortality rate	P
2.11	Overall fishing mortality rate	P
2.12	Species richness in catch	S
2.13	Mean size (length or weight) of all organisms sampled	S
2.14	Total catch size frequency distribution	S
2.15	Fraction of stocks fully and/or sustainable exploited; fraction of commercial fisheries where predicted catches are observed	S
2.16	Total biomass, total abundance	S
2.17	Fractions of stocks outside safe biological limits	S
2.18	Slope of the size spectrum in the catch	S
2.19	Species diversity in the catch-dominance curves	S
2.20	Genetic diversity of bycatch species	S
2.21	Total production	S

P: social pressure; S: ecosystem state

Table 7. List of indicators describing resource system (habitat quality and complexity)

Number	Indicator	Type
3.1	Fraction of habitat lost or destroyed	P
3.2	Number of marine protected areas	P
3.3	Fraction of littoral area protected (totally, partially)	P
3.4	Relative area of each national/regional marine environment/ecosystem/habitat under protection	P
3.5	Fishing effort by method, area, year or season	P
3.6	Ratio of fished to protected (unfished) habitat	P
3.7	Fraction of habitat changed by fishing activities	P
3.8	Extent of selected marine habitat	S
3.9	Spatial integrity habitats	S
3.10	Area of available habitat occupied (by selected species or assemblages)	S
3.11	Habitat diversity	S
3.12	Fraction of endangered/protected species/stocks where interaction with fisheries exists	S
3.13	Extent of critical habitats (spawning, nursery, migration pathways, etc)	S
3.14	Numbers of communities identified	S
3.15	Spatial fragmentation of communities	S
3.16	Biodiversity condition of selected marine habitat and communities at selected sites	S
3.17	Sex ratio (e.g. some marine mammals, some crustaceans)	S
3.18	Indicators related to terrestrial/freshwater inputs	S
3.19	Eutrophication-related indicators	S
3.20	Climate-change-related indicators	S
3.21	Pollution-related indicators	S

P: social pressure; S: ecosystem state

Table 8. List of indicators describing the biological system (ecosystem functioning)

Number	Indicators related to single species	Type
4.1	Number of non-target species caught by method, area, season, year	P
4.2	Exerted effort	P
4.3	Changes in predation pressure (e.g. through removal of predators)	P
4.4	Fishing-in-balance (FIB) index	P
4.5	The number of taxa in IUCN and national threatened categories	S
4.6	Number of exotic species	S
4.7	Abundance of exotic species	S
4.8	Presence of indicator / charismatic / sensitive species, possible by community	S
4.9	Biomass and/or abundance and/or breeding success of key dependent predators (e.g. seabird species)	S
4.10	Population size /abundance /of charismatic species	S
4.11	Population size of sensitive / protected /endangered / threatened species	S
4.12	Average disease / parasite prevalence in ecosystem	S
4.13	Indicators of species diversity: species richness, richness of species assemblages, k-dominance curves, Multidimensional Scaling (MDS), species effort index	S
4.14	Number of population size of sensitive species or species at risk	S
4.15	Survey indices of non-target or non-commercial species: abundance, recruitment	S
4.16	Abundance of keystone species	S
4.17	Indicators of live history strategy: changes in reproductive parameters (age at maturity, time of breeding), lifetime reproductive success rates (early *vs.* late maturation schedules)	S
4.18	Population trends or relative abundance of indicator species	S
4.19	Number of breeding individuals in Evolutionary Significant Units	S
4.20	Genetic diversity within subpopulations	S

(cont. Table 8)

Indicators related to single species		
4.21	Abundance of alternative prey for predators	S
4.22	Fat content of selected species (as proxy for food availability and quality of food)	S
4.23	Mean and distribution in the body of contaminant burden	S
4.24	Predator-induced mortality rates on prey populations	S
4.25	Total production in ecosystem	S
4.26	Invasibility of food webs	S
4.27	Indicators of trophic composition, food change structure, productivity and flow	S
4.28	Effective number of species within trophic levels, proportion of species at range of trophic levels	S
4.29	Food web complexity: number of trophic levels, proportion of species at range of trophic levels	S
4.30	Throughput, ratios of system-internal consumption to yield, flows from producer`s level required to sustain the fishery	S
4.31	Return time of food webs after perturbation	S
4.32	Carrying capacity	S
4.33	Condition factor (average condition of a theoretical community of fixed size-structure and species composition)	S
Size-based indicators		
4.34	Overall size distribution in ecosystem, slope of ecosystem size spectrum	S

P: social pressure; S: ecosystem state

PART 4. TRADE-OFFS IN ECOSYSTEM APPROACH TO FISHERIES MANAGEMENT

4.1. Including human in the ecosystem

Hilborn *et al*. (2004), in their critical paper, argue that overfishing is a symptom of poor governance systems rather than the structural disease to be treated. They propose and discuss the hypothesis that sustainable fishing will occur when the institutional framework encourages the participants to behave in a way that is societaly desirable.

In relation to ecosystem-based management, Hilborn *et al*. (2004) propose a number of approaches alternative to estimating "ecosystem-based" catch limits that could provide steps toward ecosystem management, including: (i) maximizing yield with trophic interactions; (ii) maximizing the sum of single-species benefits; (iii) manage to preserve all species at a level that will produce single-species maximum sustainable yield, commonly called "weak-stock management"; and (iv) modifying the economic structure of the fisheries to cope better with changes in ecosystem structure and expanding the model used to provide management advice to include a broader concept of "ecosystems".

Hilborn *et al*. (2004) show several examples of failures and successes in single-species fisheries management in some countries, illustrating that individuals and groups acting to maximize their own welfare can produce societally desirable outcomes. According to Hilborn *et al*. (2004), fisheries management can be done either "top down", by means of regulations, enforcement, and lawsuits, or "bottom up", by means of incentives set so that participants in the fishery acting in self interest will promote conservation. Bottom up management is the carrot, top down management is the stick.

4.2. Trade-offs in groundfish fisheries

According to Brodziak *et al*. (2004), the pattern of chronic overfishing is epitomized by the Georges Bank haddock fishery, which has been overfished for decades. In general, as fish stocks decline, fishing technologies steadily improve. As fishing gears become more efficient, target species also change. Increased efficiency and higher fishing effort eventually lead to further declines and depleted stocks. Since the mid 1990s, some New England groundfish stocks (e.g. yellowtail flounder) have increase in abundance in response to direct controls on fishing mortality (e.i. fishing effort limitations) and other significant conservation measurements (i.e large-scale closed areas and fishing gear restrictions), but the Georges Bank and Gulf of Maine cod stocks have shown little recovery and are still overfished. In opinion of these authors, continued overfishing of the cod stocks has generated a major controversy over the efficacy of groundfish management. Moreover, Hennesey & Healy (2000 *fide* Brodziak *et al*. 2004), have pointed out that the positive feedback between political power and continuing investment in a declining natural resource provides a good description of the New England groundfish fishery-management process from the end of 1970s, but significant reductions in fishing effort will nonetheless occur in the near future either under court order or through the fishery management plan amendment process.

Brodziak *et al*. (2004) certainly declare that, at a minimum, implementing ecosystem management will entail further reductions in fishing capacity, greater use of marine protected areas, continuation of fishing effort limitations, and increased ecosystem monitoring. Ideally, an ecosystem-based approach will allow for simultaneous consideration of risks to target species, prey species, by-catch species, protected species, essential fish habitat, secondary effects of fishing vessels and gear, and effects on fishing communities. According to these authors, one of the impediments to achieving an ecosystem-based approach to fisheries management is overcapacity which, in their opinion, is the key problem to be resolved in New England fisheries; the same is the opinion of the authors of the present report to APEC for the majority of groundfish fisheries in many countries. Thus, reductions in fleet capacity are an essential precondition for the success of management measures designed to eliminate overfishing, minimize by-catch problems, reduce environmentally destructive fishing practices, reduce underreporting, and improve government-industry relations, all of which are also key ingredients of ecosystem-based management. Also, eliminating overcapacity would probably be by far the largest transition cost, both in monetary and social terms, associated with fishery adaptation to sustainable management. On the contrary, from an ecosystem perspective, increases in net benefits are unlikely to result from maintaining the *status quo* (Brodziak *et al*., 2004), i.e. single-species management.

4.3. Trade-offs in ecosystem-scale optimization of fisheries management policies

Christensen & Walters (2004) conclude that a stage has been reached where ecosystem models can be used to describe with some credibility mortality agents and trophic interdependence in the marine environment. They consider the exploration of policy decision-making processes important for testing the behavior of ecosystem models. A useful model is one that correctly orders a set of policy choices, i.e. makes correct predictions about the relative values of variables that matter to policy choice. The software used was Ecopath with Ecosim.

4.3.1. Objectives

The following three objectives were used to begin considering policy optimization at the ecosystem level: (i) maximize economic profit, (ii) maximize landed value of the catch, and (iii) maximize "ecosystem structure". Christensen & Walters (2004) tested their model to multi-fleets in the Gulf of Thailand. The model considered topics like:

- profit and catch value,
- ecosystem structure,
- maximizing longevity-weighted biomass,
- biomass diversity index, and
- average trophic level of the catch.

Applications of policy optimizations for multi-fleets have been done also by Arancibia & Neira (2003) in central Chile and Arreguín-Sánchez (2004) for Baja California Sur.

4.4. Managing fisheries effects on marine food webs: trade-offs among harvest strategies, monitoring, and assessments in achieving conservation objectives

Constable (2004) presents general principles of an ecosystem-based approach to fisheries using the methods of the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLAR) as examples. He discusses the precautionary and ecosystem approaches of CCAMLAR, the types of objectives being consider for predators and the monitoring programs that could be used to achieve ecosystem/food web conservation objectives. The approaches are intended to permit both recovery of overexploited species and ecologically sustainable development of fisheries without causing damage to the Antarctic marine ecosystem. Table 9 summarizes the principles encompassed in ecosystem-based management, according to Constable (2004).

Table 9. Summary of characteristics of the ecosystem approach to managing fisheries (after Constable, 2004).

The ecosystem approach	In contrast, it
Manage peoples/activities	Does not manage ecosystems
Consider ecosystem effects	Is not ecosystem engineering
Permits action despite incomplete knowledge	Does not delay action until ecosystems are completely understood
Is robust in the face of uncertainties	Is not based on a single comprehensive predictive model that can be used to make decisions
Makes explicit trade-offs of ecological, social and economic risks	Does not necessarily make the assumption that improved detail/complexity will result in diminished risk in all areas
Requires greater precaution than single species (use) management	Should not lead managers to be less precautionary than does the precautionary approach
Keeps costs commensurate with value	Does not regard costs as immaterial

4.4.1. The ecosystem approach to managing fisheries

According to Constable (2004), CCAMLR is known as the only international convention currently applying an ecosystem approach to managing fisheries. The development of an effective management procedure requires (i) operational objectives, (ii) methods for assessing the status of the system after the monitoring of indicators, and (iii) the decision rules for setting harvest controls based on the relative difference between the assessment and the objectives while accounting for uncertainties.

4.4.2. Operational objectives for predators of fished species

Species that directly interact (as predator or prey) with the target and by-catch species of fisheries (also termed "fished species") are those most likely to exhibit an indirect response to fishing, particularly those with the strongest interactions with the fished species. Three types of operational objectives can be formulated: (i) maintaining biodiversity of the ecosystem; (ii) minimizing competition between fisheries and predators of target species; and (iii) maintaining productivity of predators of fished species.

- Maintaining biodiversity

For ecological assemblages, attention seems to be focused on the maintenance of biodiversity and the potential consequences of biodiversity declines to the overall ecological function of those assemblages. In this case, field research is concentrated on identifying models to understand the implications of those changes.

- Minimizing competition

Two approaches to minimizing competition between fisheries and predators have been discussed in CCAMLR. The first is to reduce the potential for interference with foraging of land-based predators by reducing overlap of predator foraging areas and fishing grounds. The second approach is to limit fishing to a level that does not alter the mean fitness of predators (Boyd, 2002 *fide* Constable, 2004).

- Maintaining productivity of predators

Three types of krill-fishery management procedures based on maintaining the productivity of predators dependant on the consumption of krill have been presented to the CCAMLR Scientific Committee. They are: (i) maintenance of the median escapement from the fishery of the krill spawning stock at ¾ of the median preexploitation level; (ii) maintenance of abundance of predators at or above ½ of that prior to harvesting of prey; and (iii) maintenance of median annual predator productivity attributed to consumption of harvested species at or above 80% of its preexploitation level.

According to Constable (2004), the evaluation of potential management procedures for the full development of a fishery also involves building simulation models of the system to determine how well the operational objectives for the ecosystem can be met given a combination of decision rules, monitoring programs, and assessment methods and should enable addressing the following three questions:

- what combinations of monitoring, assessments and decision rules meet the required performance standards for different plausible formulations of the ecosystem?
- could the different parts of the management system be simplified and work just as effectively?
- how the performance of the management system could be improved by changes in decision rules.

The advantage of such evaluations is that the initial management system can be built on the simplest decision rules and then it can be progressively modified to improve performance, according to the performance criteria.

4.5. Can there be agreement on a standardized approach to ecosystem-based fishery management?

In opinion of Babcock and Pikitch (2004), some form of ecosystem-based fishery management (EBFM) or at least incorporation of ecosystem principles into management is required by a many recent law, treaties, and agreements, such as the Plan of Implementation from the World Summit on Sustainable Development 2002.

According to Babcock and Pikitch (2004), if a new management scheme based on ecosystems is to replace management of individual species, presumably some standard related to fisheries yield would remain an objective of management. Maintaining biodiversity or some other measure of ecosystem health would also be an important objective. To manage ecosystems instead of single species will require ecosystem-based biological reference points, performance indicators, and control rules that are based on assessment of ecosystem status and predictive ecosystem models (Murawski, 2000).

Rice (2000) developed a taxonomy of metrics of community structure, with four broad categories: (1) diversity indices based on species richness, evenness, and dominance; (2) ordination methods applied to species composition data; (3) aggregate indicators of ecosystem status such as biomass size spectra; and (4) "emergent property" metrics, which are derived from ecosystem models. Possible metrics include the mean trophic level of the fishery catch from mass balance models like Ecopath/Ecosim.

According to Murawski (2000), given that a metric of ecosystem health can be found, a model will be needed that can be used to predict how the ecosystem will react to propose management actions. At present, the only possibilities seem to be mass-balance models like Ecopath with Ecosim, EwE (Pauly *et al*., 2000) and multispecies population-dynamics models like multispecies virtual population analysis, MSVPA (Collie and Gislason, 2001).

4.6. Transition from low to high data richness: an experiment in ecosystem-based fishery management from California

Kaufman *et al*. (2004) declare that few fisheries have the legal mandate for ecosystem-based fishery management or to apply precautionary management when information is lacking, so fishermen have little incentive to demand improvements in information. They present the key elements, the scientific rationale and an implementation plan for transition from information-poor, precautionary management, to information-rich, spatially explicit, ecosystem-based management in the California near-shore finfish fishery.

According to Kaufman *et al.* (2004), resource managers and fishery scientists generally agree that caution must be given higher priority in management of human impacts on wild stocks and on the ecosystems that sustain them. Agreement is also growing that fishery management must go beyond single-species to impact management to incorporate ecosystem considerations explicitly. The goal is a sustainable relationship between man and the sea. This approach, in which ecological integrity is given greater importance than short-term benefits to the human enterprise, is called "ecosystem-based management" (EBM).

In 2000, the U. S. West Coast groundfish fishery (California, Oregon and Washington), based mainly on bocaccio (*Sebastes paucispinus*) and other *Sebastes* species, was declared in a state of disaster and federal managers closed most of the continental shelf portion of this fishery. Target populations of the most state-managed fishes and invertebrates were fully or overexploited. The closures provided a strong incentive to improve management in the area.

4.6.1. Principles of control rule (Kaufman et al., 2004)

1. Certain irreducible uncertainties may never be resolved, so precaution at the outset is essential. The need for precaution can be reduced with improved information, though it is never eliminated.
2. Single-species management has commonly tended toward inadvertent over-exploitation. Ecosystem-based management requires the application of more conservative tools to address this problem and reduce the risk of overexploitation.
3. Better information may ultimately result in higher TACs.

4.6.2. Objectives for Control Rule

1. To maintain healthy populations of target species.
2. To avoid extreme fishery effects on the ecosystem.
3. To anticipate the effects of environmental change on the fished populations.

4.6.3. Control Rule Proceeds

Stage I. Data-poor (precaution the primary basis for setting TACs).
Stage II. Data-moderate (improved single-species or multispecies management and a transition from blind precautionary management to informed risk management).
Stage III. Data-rich (ecosystem-based fishery management)

According to Kaufman *et al*. (2004), the descriptions of the three stages imply a stepwise progression, but implementation will differ in degree and timing for different species and regions. The jump from Stage I to Stage II is dramatic, because the Stage II information threshold allows a fundamental change in the approach to setting TACs. Transition to Stage III, however, will proceed by small steps and cumulatively as new information is incorporated into ecosystem-impact and environmental-change models.

4.6.4. Stage I Steps for the Transition to Stage II

Under the arbitrary precaution of Stage I, the only standard for success in meeting the three control rule objectives is not exceeding TACs. Quantitative evaluation is impossible before Stage II. In anticipation of the transition to Stage II management, the quality and quantity of data necessary for less blind precaution and more informed management, must increase during Stage I. Seven areas deserve special attention:

1. Improvements to the fishery-dependent data (accuracy, completeness, and analysis of catch data and age/size composition of catches, recording catch location for evaluating data spatially).
2. Implementation of fishery-independent surveys (experimental fishing, ichthyoplankton sampling).
3. Improved life-history information for tracking ontogenetic changes in life stages (time and environmental conditions).
4. Selection of study areas subject to varied fishing effort in each region and initiation of comparative studies of those areas in preparation for Stage II and Stage III management.
5. High-resolution mapping of near shore habitats.
6. Discard-survival studies of the target species.
7. Incorporation of existing and new ecosystem information into fishery models (food-web studies, physical oceanographic information).

4.6.5. Stage II: Improved Single- and Multispecies Management in Data-Moderate Environment

Stage II management can be implemented when data streams from the first six sources listed above are incorporated into models used to set TACs. Stage II represents a major reduction in uncertainty over Stage I, and concomitantly smaller need for strictly precautionary management. Stage II management incorporates population modeling and other analyses that replace the strictly precautionary approach to TACs in Stage I.

4.6.6. Stage III: Ecosystem-Based Management in a Data-Rich Environment

According to Weber and Heneman (2000 *fide* Kaufman *et al*., 2004), the California Marine Life Management Act requires that fishery impacts be managed so as to “conserve the health and diversity of marine ecosystems and marine living resources”. This goal is ambitious given that even first-order ecological relationships are still only poorly understood.

<u>Making the Shift to Stage III Management</u>

In Stage III the data for management will be expanded beyond the species-specific life-history and population parameters that form the backbone of Stage II, to encompass non-target species and physical oceanography. As new information becomes available, models complementary from both single-species and ecosystem perspectives can be incorporated into a powerful forecasting protocol. According to Kaufman *et al*. (2004), the threshold for shifting to Stage III management under a Fishery Management Plan includes the following conditions:

1. The comparison of study areas subject to varied fishing effort, including reference reserves, in each region. These comparisons will provide data on alteration to food-web and other aspects of ecosystem function that are attributable to fishing and may provide additional useful information for establishing TACs that take basic ecosystem conservation into consideration.
2. Together with physical oceanographic information, the comparison of protected reference areas with areas open to fishing. This approach will provide data that isolate the influence of climate (or other forces extrinsic to the fishery) and may permit the reduction of TACs to protect populations under stress or increases in TACs during periods of high productivity.

If these two conditions area satisfied, then confidence will be much greater about (i) possible ecosystem effects of the fishery and (ii) effects of environmental change on the fishery. This level of information, in turn, can drastically reduce the need for precautionary reductions in calculating TACs.

Trophic Parameters

Trophic parameters are quantitative measures of predator-prey relationships that define the overall structure of a food web. They offer a potentially very useful and sensitive reflection of differences in ecosystem function over time and between reference and exploitation areas. Kaufman *et al*. (2004) present an initial list of trophic parameters worth considering in ecosystem-based management (EBM):

- **Effective Trophic Level.** Effective trophic level (ETL) is a number that describes how high in a food web, on average, a particular individual has been feeding. When combined with age and growth data, ETL can be used to quantify changes in the life history of an individual, population, or species through ontogeny.
- **Maximum Food-Chain Length (MFChL).** It is an estimate of the maximum number of trophic links in a community. It can be derived either from the number of trophic levels below apex predator in a community or from the maximum level of heavy nitrogen enrichment exhibited by the top carnivore in the assemblage. Together, ETL and MFChL offer sensitive measures of "fishing down" in a marine food web that have not been widely utilized.
- **Connectance.** It is one of several biologically meaningful measures of food-web complexity that can be related to community stability. Connectance is the proportion of all of the theoretically possible connections in a food web that are actually present.

Functional Diversity

Ecologists have found that several measurements of community diversity have useful relationships to community properties such as productivity, ecosystem size, and various kinds of stability, including:

- **Species Richness.** It is the number of species that occur within a given area.
- **Evenness.** It is a measure of the shape of the relative abundance curve over all the species in the community. Shifts in evenness can provide an early warning of major changes in relative abundance to come.
- **Functional Complementarity.** Within any ecological community, several species may fulfill more or less the same ecological role. Such species are considered members of the same functional group, or guild.

Environment Influences

According to Kaufman *et al*. (2004), the implementation of Stage III management also incorporates existing or anticipated effects on the fishery attributable to environmental change. Existing theory and practice provide key parameters for initial consideration: (i) presence or absence of short-term or long-term environmental change (e.g. a severe El Niño or La Niña, or a shift in the Pacific Decadal Oscillation) that may result in a sharply depressed or elevated productivity or in other changes in the fishery; (ii) sea-surface temperature as a proxy for the effects of environmental change; and (iii) shifts in abundance in populations that covary with fishery management plan species or relevant non-target species.

4.7. Performance indices that facilitate informed, value-driven decision making in fisheries management

Nowlis (2004) develops and explores the use of five indices representing resilience, yield productivity, yield constancy, capacity constancy, and ecosystem productivity to evaluate natural-resource management alternatives. These indices can give fishery managers a framework within which to ask for scientific advice, and scientists a mechanism for presenting likely consequence of management decisions without favoring particular values

According with Nowlis (2004), natural resource managers rarely explicitly address the many trade-offs resulting from the biological, physical and socioeconomic limitations of the systems that produce, extract, and manage renewable natural resources. Conflicts among different values are usually addressed opaquely through political pressure rather than informed reason (Ludwig *et al*., 1993; Pauly *et al*., 2002). Scientists contribute to this failing by not providing managers with adequate information for fear of advocating values instead of supplying objective science. Managers contribute by not asking scientists for such information explicitly.

Trade-offs less well known among policy makers, despite long histories of scientific exploration, include those between yield productivity (high average catches), and yield constancy (high probability that next year's catches will be similar to this year) and between yield and ecosystem productivity, measured in terms of the abundance of a stock in the ecosystem (high yield constancy can be correlated with maintenance of greater stock abundance). Additional studies (Butterworth and Punt, 1999) have identified a three-way trade-off among yield productivity, yield constancy, and resiliency (the ability of a management system to perform well despite uncertainties), in which gains in any one necessitates losses in one or both of the others. Trade-offs are even known among the potential yields from co-occurring species caught in the same fishery.

Nowlis (2004) declares that indices are invaluable for guiding interactions between scientists and managers and for informing the general public about potential outcomes of management decisions, yet scientists have rarely examined the relative success of various policy alternatives at achieving management objectives. In opinion of Nowlis (2004), natural-resource managers should calculate performance indices as a standard practice because that would result in better and more transparent decision making, and they facilitate clear and direct comparisons of alternatives.

4.7.1. Methods

Each index ranges from 0 (bad) to 1 (good).

- **Resiliency index (I_R).** It represents the capacity of the management system to maintain productive fish populations and fisheries despite sustained directional management errors, that is, consistent over- or underestimation of the productive capacity or abundance of the population. It is based on the level of error in the fishing rate that drives a population to undesirable abundance levels and it is defined as
-

$$I_R = \varepsilon_{0.2} / (\varepsilon_{0.2} + 4)$$

  where $\varepsilon_{0.2}$ is the error value in the estimate of productivity or actual catch that drives the average population abundance down to N = 0.2, i.e. 20% of carrying capacity (a level commonly used as an undesirable abundance level in similar studies; Butterworth and Punt, 1999). To constrain the index between 0 and 1, it is divided by the sum of itself and a constant of 4 (representing 400% error and defining the level of error that would receive an index score of 0.5), chosen on the basis of Nowlis' experience with poorly studied species.

- **Yield productivity index (I_{PY}).** It characterizes the expected size of catches. The equation of yield productivity is

$$I_{PY} = h_{av} / p$$

where h_{av} is the average yield from the fishery and p is the maximum sustainable yield, the natural normalizer because it is the maximum value that can be sustained from a fishery with perfect information and a stable environment.

- **Yield-constancy index (I_{CY}).** It is a measure of variability in yield over time (standard deviation, σ_h). It is expressed as

$$I_{CY} = \begin{cases} 1 - \left(\dfrac{\sigma_h / \bar{h}}{\sigma_p / p} \right) & \dfrac{\sigma_h}{\bar{h}} < \dfrac{\sigma_p}{p} \\ & \text{if} \\ 0 & \dfrac{\sigma_h}{\bar{h}} < \dfrac{\sigma_p}{p} \end{cases}$$

- **Capacity constancy index (I_{CC}).** It illustrates the management system's ability to avoid build-up of excess capacity early in a fishery and/or during good years, when allowable catches greatly exceed long-term average catches under certain management policies. It is the maximum amount of fishing allowed in a control rule relative to the average yield and it is calculated as

$$I_{CC} = h_{av} / h_K$$

where h_K is maximum permissible catch (likely to be highest when the population is at carrying capacity, K), and h_{av} is long-term average catch.

- **Ecosystem productivity index (I_{PE}).** It is simply fish abundance, the most direct measure of the ability of fish populations to contribute to ecosystems. It is equal to the average abundance of the population (N_{av}), already normalized in the model. It is expressed as
-

$$I_{PE} = N_{av}$$

4.8. Ecosystem consideration in fisheries management: theory and practice

Parsons (2005) examines recent international developments with respect to development and application of the ecosystem approach in marine fisheries management. He analyze references to conserving/protecting marine ecosystem in international conventions and other legal instruments, e.g. the 1995 FAO Code of Conduct for Responsible Fisheries, the 1995 UN Fish Stocks Agreement, the 1995 Convention on Biodiversity (Jakarta Mandate on Coastal and Marine Biodiversity), and so on.

Parsons (2005) mentions three advances at the national and regional level in emphasizing the need to take a more holistic approach to fisheries management, e.g. Australia, Canada, and the Northeast Atlantic.

Australia released an Ocean Policy in 1998. The first section describes broad goals, planning and management principles to guide the development of an integrated oceans management framework. The second part describes specific measures sector by sector, e.g. fisheries. Australia's ecosystem-based planning and management approach aims to ensure the maintenance of:

- ecological processes in all ocean areas, including, for example, water and nutrients, community structures and food webs, and ecosystem links;
- marine biological diversity, including the capacity for evolutionary change; and,
- viable populations of all native marine species in functioning biological communities.

The Policy Guidelines for Oceans Planning and Management of Australia provide the following guidelines for the maintenance of ecosystem integrity:

- ecological links between the land and oceans, as well as within and between ocean ecosystems, must be taken into account in ocean planning and management;
- maintenance of natural ecosystem structure and functioning should be used to develop agreed objectives and indicators for ecosystems and resource uses on the basis of the best available information on assessment.

The Canadian Parliament passed the Oceans Act in December 1996. According to Parsons (2005), it was the first comprehensive oceans management legislation in the world and provides for the development and implementation of a national oceans management strategy based on the principles of sustainable development, integrated management and the precautionary approach.

Canada's Oceans Strategy (2002) emphasizes the promotion of an ecosystem-based approach to management. In 2004, the Canadian Department of Fisheries and Oceans defined ecosystem-based management as "the management of human activities so that ecosystems, their structure (e.g. diversity of species), function (e.g. productivity) and overall environmental marine quality are maintained at appropriate temporal and spatial scales. Ecosystem-based management recognizes that human activities must be managed in consideration of the interrelationships between organisms, their habitats and the physical environment".

Canada's ecosystem-based management approach involves:

- identifying the geographical context for management areas;
- understanding of marine ecosystem;
- assessing the condition of the ecosystem;
- managing human activities;
- establishing ecosystem objectives to maintain biodiversity, productivity, water quality and habitat quality in a given ecological region; and,
- selecting and monitoring ecological indicators to ensure that ecological objectives are being met.

In 2004, the Canadian Department of Fisheries and Oceans defined several marine ecoregions for the purpose of ecosystem-based integrated management. And in 2005 the Canadian Government announced funding for an Oceans Action Plan.

For the Northeast Atlantic, the Intermediate Ministerial Meeting, IMM (Bergen, 1997) adopted a statement of conclusions on the integration of fisheries and environmental issues. According to Parsons (2005), the IMM Statement proposed the principle of "Further integration of fisheries, environmental protection, conservation and management measures, drawing upon the development and application of an ecosystem approach, which, as far as the best available scientific understanding and information permit, is based on, in particular:

- the identification of process in, and influences on, the ecosystems which are critical for maintaining their characteristic structure and functioning, productivity and biological diversity;
- taking into account the interaction among the different components in the food webs of the ecosystems (multi-species approach) and other important ecosystem interactions; and,
- providing for a chemical, physical and biological environment in theses ecosystems with a high level of protection of these critical ecosystem processes".

The Fifth Meeting of the Conference of Parties to the Convention of Biological Diversity (COP 5) interpreted an "***ecosystem approach***" as a strategy for the integrated management of natural resources that equitably promotes both conservation and utilization. An ecosystem approach focuses on "levels of biological organization, which encompass the essential processes, functions and interactions among organisms and their environment", but it also recognizes that humans are an integral part of ecosystems. In reality, whatever the terminology, ***we are not taking about managing ecosystems. Rather, we are taking about managing the human activities which are part of, and impact on, marine ecosystems***.

4.9. Ecosystem-based management and its application to the North Pacific (PICES)

4.9.1. Introduction

In October 2003, the North Pacific Marine Science Organization (PICES), through its Science Board, established the Study Group on ecosystem-based management science and its application to the North Pacific (WG-EBM). The final report of the Study Group (Jamieson and Zhang, 2005) includes an overview of international ecosystem-based management (EBM) history, and summaries of each country's approach to EBM (Canada, China, Japan, Korea, Russia and the United States of America). The terms of reference of the WG-EBM considered:

- describe and implement a standard reporting for amt for EBM initiatives (including more than fishery management) in each PICES country, including a listing of the EBM objectives of each country;
- describe relevant national marine ecosystem monitoring approaches and planes and types of models for predicting human and environmental influences on ecosystems. Identify key information gaps and research and implementation challenges;
- evaluate the indicators from the 2004 Symposium on "Quantitative ecosystem indicators for fisheries management (Paris, March 31-April 3) for usefulness and application to the North Pacific;
- review existing definitions of "eco-regions" and identify criteria that could be used for defining ecological boundaries relevant to PICES;
- and other two aspects (inter-sessional workshop and further activities).

Under the overarching objective of conservation of species and habitat, Jamieson and Zhang (2005) concluded that EBM is the implementation of defined objectives related to maintaining and monitoring biodiversity, productivity and physical and chemical properties of an ecosystem. EBM world-wide is now recognized as both timely and necessary because (i) in many environments, individual ecosystem components are presently being utilized, harvested or impacted with limited attention to the maintenance of the integrity of the overall ecosystem, and (ii) the scale of these impacts is now such that there is real danger of overall negative ecosystem change to the detriment of human society.

4.9.2. Overview of international EBM history

Fisheries have generally been managed in isolation of the effects of other influencing factors, and have targeted commercially important species, without explicit consideration of non-commercial species and broader ecosystem impacts. There is the need to take a more holistic or EBM approach to ensure the sustainability of marine ecosystems.

There is an emerging consensus that management goals need to be considered at both the conceptual and operational level (Garcia and Staples, 2000). Conceptual objectives (Jamieson *et al.*, 2001) are stated in broad, general terms intended to be understandable by a general audience, and tend to be valid for long time periods. According with Jamieson and Zhang (2005), policy statements by a government or organization, for instance, can be considered conceptual objectives. But, operational objectives are the strategies by which the conceptual objectives are actually implemented. Jamieson *et al*. (2001) considered that an operational objective consisted of a verb (e.g. maintain), a specific measurable indicator (e.g. biomass), and a reference point (e.g. 50,000 t), thus allowing an action statement for management (e.g. maintain biomass of a given forage species greater than 50,000 t biomass).

4.9.3. Terminology definitions

Table 10 of this report replicates Appendix 10.2 of the PICES Scientific Report N° 29 (Jamieson and Zhang, 2005) with terms and definitions currently in use in the literature as well as a few new ones.

Table 10. Terminology definitions (after Jamieson *et al*., 2001. Appendix 10.2)

Term	Definition
Characteristic	Some property of the ecosystem, separate from our measurement of it (e.g., absolute biomass or recruitment measures for a population)
Ecosystem	The spatial unit and its organisms and natural processes (and cycles) that is being studied or managed.
Ecosystem-based management	A strategic approach to managing human activities that seeks to ensure through collaborative stewardship the coexistence of healthy, fully functioning ecosystems and human communities (towards maintaining long-term system sustainability by integrating ecological, economic, social, institutional and technological considerations.
Indicator (attribute)	Quantity that can be measured and be used to track changes over time with respect to an operational objective. Measurable part or process (property) of a system (e.g. average weight of age 5 individuals of a species).
Metric	Indicator empirically shown to change in value along a gradient of human influence (e.g., a population’s biomass as a result of fishing activities; number of introduced (exotic) feral species)
Multimetric index	A number that integrates several metrics to indicate a “condition” factor
Reference point	Value of an indicator corresponding to a management target or threshold
Target reference point	An indicator reference point that is trying to be achieved (e.g., an estimated biomass of 30,000 t)
Limit reference point	An indicator reference point that if crossed results in the implementation of a management action (e.g., if the estimated biomass falls below 10,000 t, the fishery is closed)
Conceptual objective	General statements that are uniformly accepted by all stakeholders as desirable. They are specific enough that everyone will interpret them the same way, but do not specify how they will be measured
Operational objective	Objective that has a direct and practical interpretation in the context (fisheries, habitat) management and against which performance can be evaluated quantitatively. A specific statement that consists of a verb (e.g. maintain), a specific measurable indicator (e.g., estimated biomass), and a reference point (e.g., 50,000 t), thus allowing an action statement for management (e.g., maintain estimated biomass of a given forage species greater than 20,000 t biomass).

5. REFERENCES

Arancibia, H. and S. Neira. 2005. Modelling predation of common hake (*Merluccius gayi*) by jumbo squid (*Dosidicus gigas*) in central Chile (33°S - 39°S). Abstracts of the Third International Symposium on Squids, Lima, Peru, November 28-30, 2005.

Arancibia, H. & S. Neira. 2003. Simulación de cambios en la biomasa de los principales recursos pesqueros de Chile central (V – IX Región) bajo el marco de la Ley de Pesca N° 19.713 y sus posteriores modificaciones. Universidad de Concepción, 51 p.

Arreguín-Sánchez, F., A. Hernández-Herrera, M. Ramírez-Rodríguez and H. Pérez-España. 2004. Optimal management scenarios for the artisanal fisheries in the ecosystem of La Paz, Baja California Sur, Mexico. Ecological Modelling 172 (2-4):373-382.

Arreguín-Sánchez, F., M. Zetina-Rejón, S. Manickhand-Heileman, M. Ramírez-Rodríguez and L. Vidal. 2004. Simulated response to harvesting strategies in an exploited ecosystem in the southwestern Gulf of Mexico. Ecological Modelling 172 (2-4):421-432.

Babcock, E. A. & E. K. Pikitch. 2004. Can we reach agreement on a standardized approach to ecosystem-base fishery management? Bull. Mar. Sci. 74(3):685-692.

Brodziak, J. K., P. M. Mace, W. J. Overholtz & P. J. Rago. 2004. Ecosystem trade-offs in managing New England fisheries. Bull. Mar. Sci. 74(3):529-548.

Butterworth, D. S. and A. E. Punt. 1999. Experiences in the evaluation and implementation of management procedures. ICES J. mar. Sci. 56:985-988.

Butterworth, D. S. and É. E. Plagányi. 2002. A brief introduction to some approaches to multispecies/ecosystem modeling in the context of their possible application in the management of South African fisheries. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:53-61.

Cochrane, K. L., Butterworth, D. S., de Oliveira, J. A. A. and B. A. Roel. 1998. Management procedures in a fishery based on highly variable stocks and with conflicting objectives: experiences in the South African pelagic fishery. Revs. Fish Biol. Fish. 8:177-214.

Cochrane, K. L., C. J. Augustyn, A. C. Cockcroft, J. H. M. David, M. H. Griffiths, J. C. Groeneveld, M. R. Lipinsky, M. J. Smales, C. D. Smith and R. J. Q. Tarr. 2004. An ecosystem approach to fisheries in the southern Benguela context. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:9-35.

Collie, J. S. and H. Gislason. 2001. Biological reference points for fish stocks in a multispecies context. Can. J. Fish. Aquat. Sci. 58:2167-2176.

Constable, A. J. Managing fisheries effects on marine food webs in Antarctica: trade-off among harvest strategies, monitoring, and assessment in achieving conservation objectives. Bull. Mar. Sci. 74(3):583-605.

Cury, P., Bakun, A., Crawford, R. J. M., Jarre, A., Quiñones, R., Shannon, L. J. and H. M. Verheye. 2000. Small pelagics in upwelling systems: pattern of interactions and structural changes in "wasp-waist" ecosystems. ICES J. mar. Sci. 57:603-618.

Charles, T. 2002. Use rights and responsible fisheries: limiting access and harvesting through rights-based management. In: A Fishery Manager´s Guidebook. Cochrane, K. L. (Ed.) FAO Fish. Tech. Pap. 424:131-157.

Christensen, V. 1996. Managing fisheries involving predator and prey species. Revs. Fish Biol. Fish. 6:417-442.

Christensen, V. and C. J. Walters. 2000. ECOPATH with ECOSIM: methods capabilities and limitations. In: Methods for Assessing the Impact of Fisheries on Marine Ecosystems of the North Atlantic. Pauly, D. and T. J. Pitcher (Eds). Fish. Centre Res. Rep. 8(2):79-105.

Christensen, V. and C. J. Walters. 2004. Ecopath with Ecosim: methods, capabilities and limitations. Ecological Modelling 172 (2-4):109-139.

Degnbol, P. and A. Jarre. 2004. Review of indicators in fisheries management. A development perspective. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:303-326.

Drapeau, L., L. Pecquerie, P. Fréon and L. J. Shannon. 2004. Quantification and representation of potential spatial interactions in the southern Benguela ecosystem. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:141-159.

FAO. 1995. Code of Conduct for Responsible Fisheries. FAO, Rome: 41 p.

FAO. 2001. Report of the Reykjavík Conference on Responsible Fisheries in the Marine Ecosystem. Reykjavík, Iceland, October 2001. Fish. Rep. 658: 135 p.

FAO. 2003. Fisheries Management 2. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries. 4 (Suppl. 2):112 p.

Fulton, E. A. and A. D. M. Smith. 2004. Lessons learnt from a comparison of three ecosystem models for Port Philip Bay, Australia. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:219-243.

Garcia, S. M. and D. J. Staples. 2000. Sustainability reference systems and indicators for responsible marine capture fisheries: a review of concepts and elements for a set of guidelines. Mar. Freshwat. Res. 51:385-426.

Gasalla, M. A. and C. L. D. B. Rossi-Wongtschowski. 2004. Contribution of ecosystem analysis to investigating the effects of changes in fishing strategies in the South Brazil Bight coastal ecosystem. Ecological Modelling 172 (2-4):283-306.

Gislason, H., M. Sinclair, K. Sainsbury and R. O'Boyle. 2000. Symposium overview: incorporating ecosystem objectives within fisheries management. ICES J. mar. Sci. 57: 468-475.

Hardin, G. 1968. The tragedy of the commons. Science 162:1243-1248.

Heymans, J. J., L. J. Shannon and A. Jarre. 2004. Changes in the northern Benguela ecosystem over three decades: 1970s, 1980s, and 1990s. Ecological Modelling 172 (2-4):175-195.

Hilborn, R., A. E. Punt & J. Orensanz. 2004. Beyond band-aids in fisheries management: fixing world fisheries. Bull. Mar. Sci. 74(3):493-507.

Jamieson, G., R. O'Boyle, J. Arbour, D. Cobb, S. Courtenay, R. Gregory, C. Levings, J. Munro, I. Perry and H. Vandermeulen. 2001. Proceedings of the National Workshop on Objectives and Indicators for Ecosystem-Based Management. Sydney, B.C., CSAS Proc. Ser. 2001/09, 140 p. (http://www.dfo-mpo.gc.ca/csas/Csas/Proceedings/2001/PRO2001_ 09e.pdf)

Jamieson, G. and Ch-I. Zhang. 2005. Report of the Study Group on ecosystem-based management science and its application to the North Pacific. Secretariat/Publisher North Pacific Marine Science Organization. PICES Scientific Report N° 29, 77 p.

Kaufman, L., B. Heneman, J. T. Barnes and R. Fujita. 2004. Transition from low to high data richness: an experiment in ecosystem-based fishery management from California. Bull. Mar. Sci. 74(3):693-708.

Larkin, P. A. 1996. Concepts and issues in marine ecosystem management. Revs. Fish Biol. Fish. 6:139-164.

Livingston, P. A. and S. Tjelmeland. 2000. Fisheries in boreal ecosystems. ICES J. mar. Sci. 57:619-627.

Ludwig, D., R. Hilborn and C. Walters. 1993. Uncertainty, resource exploitation, and conservation: lessons from history. Science 260:17-36.

Moloney, C. L., C. D. van der Lingen, L. Hutchings and J. G. Field. 2004. Contributions of the Benguela Ecology Programme to pelagic fisheries management in South Africa. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:37-51.

Murawski, S. A. 2000. Definitions of overfishing from an ecosystem perspective. ICES J. mar. Sci. 57:649-658.

National Research Council. 1999. Sustaining marine fisheries. Washington DC, National Academy Press, 164 p.

Neira, S. and H. Arancibia. 2004. Comparative analysis of the trophic structure of commercial fishery species off central Chile in 1992 and 1998. Ecological Modelling 172 (2-4):233-248.

Nowlis, J. S. Performance indices that facilitate informed, value-driven decision making in fisheries management. Bull. Mar. Sci. 74(3):709-726.

Parsons, S. 2005. Ecosystem considerations in fisheries management: theory and practice. Conference on the Governance of High Seas Fisheries and the UN Fish Agreement. Moving from Word to Action. St. John's, Newfoundland and Labrador, May 1 to 5, 2005:42 p.

Pauly, D. 1998. Large marine ecosystems: analysis and management. In: *Benguela Dynamics: Impacts of Variability on Shelf-Sea Environments and Their Living Resources.* Pillar, S. C., Moloney, C. L., Payne, A. I. L. and F. A. Shillington (Eds). S. Afr. J. mar. Sci. 19:487-499.

Pauly, D., V. Christensen & C. Walters. 2000. Ecopath, Ecosim, and Ecospace as tools for evaluating ecosystem impact of fisheries. ICES J. mar. Sci. 57:697-706.

Pauly, D., V. Christensen, S. Guénette, T. J. Pitcher, U. R. Sumaila, C. J. Walters, R. Watson and D. Zeller. 2002. Towards sustainability in world fisheries. Nature 418:689-695.

Pecquerie, L., L. Drapeau, P. Fréon, J. C. Coetzee, R. W. Leslie and M. H. Griffiths. 2004. Distribution patterns of key fish species of the southern Benguela ecosystem : an approach combining fishery-dependent and fishery-independent data. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:115-139.

Rice, J. C. 2000. Evaluating fishery impacts using metrics of community structure. ICES J. mar. Sci. 57:682-688.

Roux, J-P. and L. J. Shannon. 2004. Ecosystem approach to fisheries management in the northern Benguela: the Namibian experience. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:79-93.

Sánchez, F. and I. Olaso. 2004. Effects of fisheries on the Cantabrian Sea shelf ecosystem. Ecological Modelling 172 (2-4):151-174.

Shannon, L. J., Moloney, C. L., Jarre, A. and J. G. Field. 2003. Trophic flows in the southern Benguela during the 1980s and 1990s. J. mar. Syst. 39:83-116.

Shannon, L. J., K. L. Cochrane, C. L. Moloney and P. Freón. 2004. Ecosystem approach to fisheries management in the Benguela: a workshop overview. Ecosystem Approaches to Fisheries in the Southern Benguela. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:1-8.

Shannon, L. and C. L. Moloney. 2004. An ecosystem framework for fisheries management in the southern Benguela upwelling system. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:63-77.

Shin, Y-J. and P. Cury. 2001. Exploring fish community dynamics through size-dependent trophic interactions using a spatialized individual-based model. Aquat. Living Resour. 14:65-80.

Shin, Y-J., L. J. Shannon and P. M. Cury. 2004. Simulations of fishing effects on the southern Benguela fish community using individual-based model: learning from a comparison with Ecosim. In: *Ecosystem Approaches to Fisheries in the Southern Benguela*. Shannon, L. J., Cochrane, K. L. and S. C. Pillar (Eds). Afr. J. mar. Sci. 26:95-114.

Shin, Y-J. and P. Cury. 2001. Exploring fish community dynamics through size-dependent trophic interactions using a spatialized individual-based model. Aquat. Living Resour. 14:65-80.

Sinclair, M. and Valdimarsson (Eds). 2003. Responsible fisheries in the marine ecosystems. Rome, FAO:426 p.

Smith, A. D. M, Sainsbury, K. J and R. A. Stevens. 1999. Implementing effective fisheries management systems. Management strategy evaluation and the Australian partnership approach. ICES J. mar. Sci. 56:967-979.

Ward, T. J. 2000. Indicators for assessing the sustainability of Australia's marine ecosystem. Mar. Freshwat. Res. 51:435-446.

ANNEX 1

QUESTIONNAIRE FOR APEC PROJECT

"Ecosystem based approach: A comparative assessment of the institutional response in fisheries management within APEC economies.
The case of demersal fisheries (Phase I) – FWG 02/2005"

Dear Colleague,

This general purpose questionnaire is part of Phase I of a project funded by Asia Pacific Economic Cooperation (APEC) that aims to evaluate the level of integration of Ecosystem Based Approaches (EBA) to the institutional framework in charge of fisheries management in each APEC economy (see Annex 1-A). The attached project has been proposed by Chile and it's co-sponsored by Chinese Taipei, Canada and the United States. Further information can be found at APEC Secretariat www1.apecsec.org.sg

We have contacted you directly or through a third party and we are asking you to fill this questionnaire. We are trying to get first hand opinions from people with scientific knowledge, technical expertise or practical experience in fisheries and/or fisheries management from different areas and with different points of view, for instance, public servants, private sector businessmen or entrepreneurs, industrial fishermen, artisanal or small-scale fishermen, academics, NGO's, etc.

Answering this document shouldn't take more than ten minutes of your time because we are asking for your knowledge and experience, not hard data or quantitative information, unless it is readily available to you.

Thank you for your time and help. Sincerely yours,

Prof. Dr. Hugo Arancibia (harancib@udec.cl)

FWG 02/2005 Project Contractor
Fisheries Technology Unit (www.unitep.cl)
Department of Oceanography
Faculty of Nature and Oceanographic Sciences
Universidad de Concepción
P. O. Box 160-C
Concepción, CHILE

IDENTIFICATION AND POSITION OF PERSON

APEC Economy	
Gender	
I. Questionaire respondt's data	
Prefix	Mrs Ms Mr
Academic Degree	Dr. M. Sc.
Field	
Last Name	
First Name	
Institution/Organization	
Position	
Current area of research/interests	
Briefly refer to the implications of your current activities for fisheries management policy-making.	
II. Contact details	
Email	
Organization website	
Other website of interest	
Postal address	
Phone Nr. (with country code & area code)	
Fax Nr.	
Other of interest	

1. How important are fisheries for your economy?

1 = Very high	2 = High	3 = Medium	4 = Low	5 = Very low

FISHERY SECTOR	ECONOMIC IMPORTANCE	SOCIAL IMPORTANCE
All Fisheries		
Industrial		
Artisanal		
Sport fishing		
Purse-seine		
Trawling		
Long-line		
Other (specify)		
Pelagic		
Benthic		
Demersal		
Fish		
Crustaceans		
Molluscs		
Seaweeds		
Other (specify)		
Beach fishing		
Coastal fishing (how far?)		
E. E. Z.		
High Seas		

2. What is your perception of fishery regulations in your economy?

SEGMENT OF FISHERY	1= COMPLEX 2= REGULAR 3= SIMPLE	1= EFFICIENT 2= REGULAR 3= DEFFICIENT	1= COMPLETE 2= REGULAR 3= INCOMPLETE
Extraction			
Transportation			
Processing			
Trading			
Resources protection			
Environment protection			
Monospecific fishery			
Multispecific fishery (EBA)			

3. What is the place of the Fishing Authority in the structure or hierarchy of the public sector in your economy?

LEVEL	Mark where appropriate
Ministry (Secretary)	
Under Secretariat (Vice Ministry)	
Inter-Ministerial Committee	
Multi-Sector Council with Executive Powers	
Multi-Sector Council with Counseling Powers	
Regional Level Autonomous Authority	
Regional Level Counseling Authority	
Other (describe):	

4. What authority or institution is in charge of the following activities with respect to fisheries in your economy?

ACTIVITY	AUTHORITY OR INSTITUTION (+ email if you know it)
Legislation proposals	
Legislation approvals	
Control of fishery sector compliance with the law	
Control of fishing fleet compliance with maritime	
Control of resources identification and landings	
Gathering and keeping of fishing statistics	
Control of processing facilities	
Control of resource processing activities	
Control of use (trade) for human consumption	
Control of use (trade) for animal feed	
Fishery research funding decisions	
Fishery research operations	
Fishery development	
Technical advisorship for political authorities	
Political advisorship for political authorities	
Other activities:	

5. What is the relative importance of different sectors in the fisheries decision-making process in your economy?

1 = Very high	2 = High	3 = Medium	4 = Low	5 = Very low

SECTOR	IMPORTANCE
Executive authority	
Legislative authority	
Fishery authority (national)	
Local executive authorities	
Local fishery authorities	
Other authorities (specify)	
Industrial fishing sector (fleet)	
Industrial fishing sector (processing)	
Artisanal fishing sector	
Businessmen/entrepreneurs	
Universities	
Public technical institutions	
Private technical institutions	
Non governmental organizations	
Woman as gender	
Other social bodies	

6. Do you know of APEC endorsed projects or proposals about …?

a) the marine environment

YES		NO	

Contact name, address and email, please:

b) fisheries

YES		NO	

Contact name, address and email, please:

7. Do you know about APEC's Political Agenda for the marine environment and fisheries?

Thoroughly	
I have some knowledge of it	
I have heard about it	
I don't know	

8. Do you know what are Ecosystem Based Approaches (EBA) for fishery management?

Thoroughly	
I have some knowledge of them	
I have heard about them	
I don't know	

9. Are EBA applied to fisheries management in your economy?

Extensively	
To some important fisheries	
To a single important fishery	
To some small fisheries	
To a single small fishery	
No	

10. If EBA is applied to fishery management in your economy, what kind or kinds of fisheries is it applied to?

FISHERY TYPE	YES/ NO	SPECIFY MARINE RESOURCES WHERE APPROPRIATE
All fisheries		
National fisheries		
Regional/local fisheries		
Industrial		
Artisanal		
Sport fishing		
Purse-seine		
Trawling		
Long-line		
Pelagic		
Benthic		
Demersal		
Fish		
Crustaceans		
Molluscs		
Seaweeds		
Other marine resources		
Beach fishing		
Coastal fishing		
E.E.Z		
High Seas		
Marine Protected Areas		

11. At what level are EBA management goals applied in your economy?

a) conceptual (i.e. policy statements)

YES		NO	

b) operational (i.e. management decisions)

YES		NO	

c) other

YES		NO	

Please specify:

12. If EBA management has not been operationally applied in your economy,

a) What could be the time scale for its application?

Soon (i.e. months)	
medium range (1 to 5 years)	
Long range (6 to 10 years)	
Not in the foreseeable future	

b) What could be the spatial scale of its application?

Restricted local areas	
Regional fisheries	
Restricted artisanal fisheries	
Artisanal fisheries	
Restricted industrial fisheries	
Industrial fisheries	
National level fisheries	
Fisheries of shared stocks	
Highly migrant resources fisheries	

Could you summarize the main problems and constraints for the implementation of EBA in fisheries in your economy, please?

Could you provide us references with contact information for other persons (name, email, address, others) you deem important in the fisheries sector of your economy (managers, stakeholders, public servans, academics, union officials, NGO's members, etc.?

I and my assistants would be grateful if you could provide us with additional information about the fishery sector in your economy, i.e. other contacts (names, emails), web pages, references on fishery policy, technical/scientific papers, fishing laws, bills statements, etc.

Kindest regards,

(Prof. Dr. Hugo Arancibia)
Concepción, Chile, April 7th, 2005

ANNEX 1-A

APEC ECONOMIES (Alphabetic Order)
Australia
Brunei Darussalam
Canada
Chile
Chinese Taipei
Hong Kong, People's Republic of China
Indonesia
Japan
Malaysia
Mexico
New Zealand
Papua New Guinea
People's Republic of China
Peru
Philippines
Republic of Korea
Russia
Singapur
Thailand
Taiwan
United States of America
Viet Nam

ANNEX 2

The 12 principles of an ecosystem approach provided by the Convention on Biological Diversity (Decision V/6)

1. The objectives of management of land, water and living resources are a matter of societal choice.
2. Management should be decentralized to the lowest appropriate level.
3. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
4. Recognizing potential gains from management, there is usually a need to understand and manage the ecosystem in a economic context. Any such ecosystem-management should: (a) reduce those market distortions that adversely effect biological diversity; (b) align incentives to promote biodiversity conservation and sustainable use; (c) internalize costs and benefits in the given ecosystem to the extent feasible.
5. Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
6. Ecosystems must be managed within the limits of their functioning.
7. The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
8. Recognizing the varying temporal scales and lag-effects that characterize ecosystem processes; objectives for ecosystem management should be set for the long term.
9. Management must recognize that change is inevitable.
10. The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biological diversity.
11. The ecosystem approach should considerer all forms of relevant information, including scientific and indigenous and local knowledge, innovation and practices.
12. The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

ANNEX 3

Principles on an ecosystem approach to fisheries (FAO, 2003).

1. Natural resources should not be allowed to decrease bellow their level of maximum productivity.
2. Fisheries should be managed to minimize their impact on the ecosystem.
3. Ecological relationships between harvested, dependent and associated species should be maintained.
4. Management measures should be compatible across the entire distribution of the resource (across jurisdiction and management plans).´
5. Because knowledge on ecosystems is incomplete, the precautionary approach should be taken.
6. Governance should be ensure both human and ecosystem well-being, and equity.

ANNEX 4

The basic structure of the FAO Guidelines on the ecosystem approach to fisheries (FAO, 2003).

1. Introduction
1.1. The need for and benefits of an ecosystem approach to fisheries (EAF)
1.2. What is an EAF?
1.3 Making EAF operational
1.4 Moving towards EAF management
2. Ecosystem approach to fisheries data and information requirements and use
2.1. Policy formulation
2.2. Developing management plans
2.3. Monitoring, implementing and performance reviews
2.4. Uncertainty and the role of research
3. Management measures and approaches
3.1. Introduction
3.2. Options and manage fishing
Technical measures
Input (effort) and output (catch) control
Ecosystem manipulation
Right-based management approaches
3.3. Creating incentives for EAF
3.4. Assessing costs and benefits of EAF
3.5. Other considerations
4. Management process
4.1. Developing an EAF management plan
4.2 Legal and institutional aspects of EAF
4.3. Effective monitoring, control and surveillance
5. Research for and improved EAF
5.1. Ecosystem and fishery impact assessment
5.2. Socio-economic considerations
5.3. Assessment of management measures
5.4. Assessment and improving the management process
5.5. Monitoring and assessments
6. Threats to implementing EAF

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