REPORT TO THE MINISTRY OF FISHERIES

14 December 01

Environmental Management Strategy - Preliminary Consultation with Environmental Stakeholders

Prepared by ECO and Forest and Bird

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1.Introduction

1.1 Purpose

This report has been prepared for the Ministry of Fisheries to inform the development of its Environmental Management Strategy (EMS). As part of the process of developing the Strategy, the Ministry commissioned ECO and Forest and Bird to:

- *Identify and describe the nature of New Zealand environmental stakeholder concerns about the management of fisheries-related impacts on the aquatic environment;*
- *Rank these concerns in order of importance to environmental stakeholders;*
- *Identify the appropriate balance between protection and use of fishery resources required to address these concerns, noting the rationale for and implications of this balance; and*
- *Identify opportunities for environmental stakeholders to work with tangata whenua and other fishery stakeholders to achieve shared environmental goals.*

ECO and Forest and Bird agreed to collaborate on this project to build on the shared goals of the two organisations and make more effective use of the funding available from the Ministry.

1.2 Consultation undertaken

To provide the opportunity for comment on the above issues, ECO and Forest and Bird prepared and circulated an 11-page discussion paper and a four-page questionnaire to over 500 members. In addition, a series of three-four hour workshops were held around the country in:

- Wanganui (ECO Annual Conference, 26 August)
- Wellington (1 November)
- Auckland (3 November)
- Bay of Islands (4 November)
- Nelson (7 November)
- Christchurch (10 November)
- Dunedin (11 November)
- Gisborne (12 November)
- Wanganui (Forest and Bird Council Meeting, 18 November)

The discussion paper and questionnaire were also available through Forest and Bird's web site.

Feedback provided in response to the questionnaire and workshops has been analysed and the results are set out in this report. In addition, the groups have researched domestic and overseas examples of environmental strategies and management approaches that could be employed to improve fisheries management in New Zealand. Comment is also included on the report prepared for the Ministry on the EMS by Trevor Ward (2001).

1.3 Acknowledgements

ECO and Forest and Bird wish to acknowledge the financial support provided by the Ministry of Fisheries to enable this consultation to be undertaken. Responses received to the

questionnaire and workshops indicate members appreciated the opportunity to take part and to share their views.

Special thanks to Jonathan Peacey and Jenni McMurrin (Ministry of Fisheries); Vicki Currie (ECO), Christine Andricksen (Forest and Bird), Colin Benson and the many people who assisted in organising workshops. We also wish to thank those who gave up their time to come to the workshops and fill in questionnaires.

1.4 Limited time frame

The groups wish to express their concern about the limited timeframe set by the Ministry for consultation. While confirmation funding for the project would be available was given in August, contracts were not completed until late-September. With the deadline initially set as 16 November, it was necessary to restrict our reach mainly to active members and member organisations.[1]

While acknowledging the Ministry agreed to the groups' request for an extension of the original timeframe, both ECO and Forest and Bird have identified a need for further consultation with the environmental community and other interests on the EMS. A proposal for further consultation is set out in Section 4 of this report.

2. General Comments

ECO and Forest and Bird welcome this opportunity to provide input into the Ministry's Environmental Management Strategy. The groups also welcome the recognition contained in the objectives of the EMS that the Ministry needs to improve its management of fisheries-related impacts on the aquatic environment and to meet its obligations under the Fisheries Act 1996.

However, to date little information has been provided by the Ministry about the precise nature and status of the EMS. It is therefore difficult to assess whether the Strategy will be able to address the institutional, legal and policy issues that environmental stakeholders have identified need to be resolved to improve fisheries management processes. Additional information to clarify the scope and legal status of the EMS would be welcomed by ECO and Forest and Bird. In the interim, recommendations have been included for further work needed in the development of the Environmental Management Strategy.

[1] However, some recreational fishers, iwi representatives and professionals did attend some workshops and/or returned questionnaires.

3. Responses to issues identified by the Ministry of Fisheries

3.1 Identify and describe the nature of New Zealand environmental stakeholder concerns about the management of fisheries-related impacts on the aquatic environment.

Six key issues regarding the management of fisheries-related impacts on the aquatic environment were identified through the consultation process undertaken by ECO and Forest and Bird. These issues describe problems relating primarily to the institutional, legal and policy frameworks under which fisheries-related impacts on the aquatic environment are managed. The key issues identified are:

- Limited opportunities for public participation in fisheries management;
- Gaps in information, monitoring and research capacity;
- Lack of precaution and environmental assessment in decision-making;
- Lack of spatial and ecotype approach to policy and planning;
- Dominance of private property rights approach;
- Lack of recognition of non-extractive use values.

These issues are discussed in detail below. Specific quotes from questionnaires and workshops are included in the right hand column.

"We need a more open public process that recognises that all New Zealanders own the fisheries resource."

"We need an open process that anyone can participate in."

"Oceans are a common resource therefore [the] public should be able to participate in [decisions about] usage – where, how much, when and who."

"Community and conservation groups should have the same rights in marine management as they have under RMA for land management."

3.1.1 Limited opportunities for public participation

The lack of opportunities and resources to take part in decision-making processes under the Fisheries Act is a key concern of environmental stakeholders.

Unlike the Resource Management Act 1991, which extends the right to participate in policy and planning processes to anyone who wishes to do so, participation under the Fisheries Act is generally restricted to "approved parties" or those expressly contacted by the Ministry.

While some informal opportunities for public participation exist through fisheries liaison committees, these committees do not have any legal standing and do not provide any formal process for public input. When asked, very few members indicated they had been given the opportunity to take part in fisheries consultation processes.

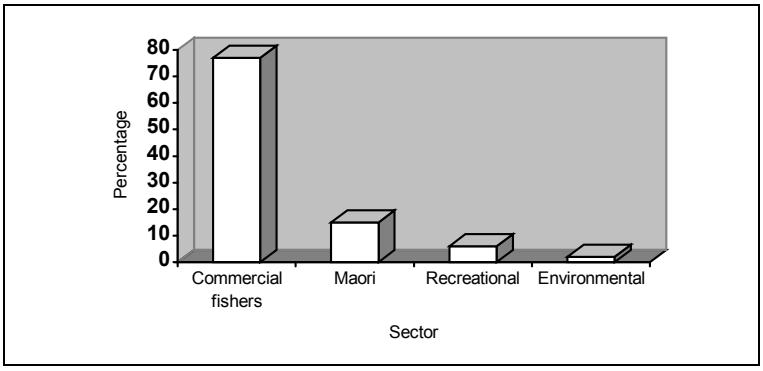
In the experience of environmental groups that have approved party status, the majority of parties who take part in fisheries consultation processes represent commercial fishing interests. Commercial sector representatives consistently out-number environmental and other interests.

Statistics provided in the Parliamentary Commissioner for the Environment's (1999) report on the management of New Zealand's

marine environment illustrate the imbalance in participation between commercial and other stakeholders in stock assessment meetings.

Figure 1 shows commercial fishers comprised nearly 80% of participating parties, over three times as much as all other parties combined. Maori representatives comprised 15%, recreational fishing interests 6% and environmental interests just 2%.

Figure 1: Participation of approved parties in stock assessment meetings



Source: Parliamentary Commissioner for the Environment (1999)

A strong view emerged during consultation with members that the Fisheries Act should provide opportunities for public participation similar to those under the Resource Management Act (RMA) and Conservation Act.

There is also a strongly held view that financial and other resources need to be provided to facilitate public participation in fisheries management. While the commercial sector has substantial resources to call on to fund its participation, non-commercial, tangata whenua, environmental and other interests often struggle to take part. Yet when members of environmental organisations participate in fisheries management processes, they do so at a cost to themselves and receive no privately appropriable benefit.

The Parliamentary Commissioner for the Environment (1999) has noted:

> *Commercial sector representatives and government officials are funded to participate in what can be extended sessions.... Participation is not necessarily an easy matter for representatives of tangata whenua, the recreational sector and conservation groups.*

Environmental interests identify the lack of resources as a significant barrier to participation. To overcome this barrier and ensure there is a balance between commercial and other interests in decision-making processes, financial assistance for public participation is seen as vitally

"All stakeholders should have an equal right to input into fisheries management processes."

"To be effective, there must be funding for public participation."

Public participation ensures decision makers are presented with all information."

"Long term objective [should be] to build ecological literacy about the marine environment."

"Should be a national policy statement for oceans."

"More information should be available to the public."

important. A number of workshop participants suggested funding assistance could be provided through a levy or royalty on fish and/or bycatch volumes or values. A possible model is the "intervener funding" system used in some Canadian jurisdictions. Under one funding scheme, a levy of 0.05% of the cost of developments was used to create a fund for public participation in planning cases.

Also identified, was the need to provide public information and education. The lack of information was raised consistently during the consultation process as a significant problem. There is a widespread view that fisheries issues are presented in an overly technical way that limits access to information to the "technically literate".

Environmental stakeholders see the limited opportunities for input under the current system as a major impediment to the effective management of fisheries-related impacts on the aquatic environment, restricting significantly the breadth and depth of knowledge and the range of values available to inform decisions.

The predominant view among the environmental community is that the oceans are a common property resource. As such, decisions regarding fisheries management must be made through an open process that fosters collective decision-making and recognises divergent interests and values.

"Educate, educate, educate."

The Ministry has failed in the past to target research widely enough to form a comprehensive picture of the marine environment."

"Research priorities should be set through a public process."

"Research priorities should be set by an independent group but with input from the public."

"Most research to date has been based around major commercial stocks. We need much more ecosystem research."

"Before research into stock numbers, our understanding of the complexity of the ecosystem is necessary."

3.1.2 Gaps in information and research capacity

The Auditor-General's 1999 report on the performance of the Ministry of Fisheries concluded:

> *the Ministry has been slow to commit resources to the environmental principles of the 1996 Act, given that it has been aware of those principles and their implications for some time.*

The report also found:

> *the Ministry manages most fish stocks without being sure if this management is sustainable…[it] is not able to make informed recommendations to the Minister on issues such as the effects of fishing on the marine environment and the inter-relationships of fish species.*

With reliable population and yield estimates available for less than 15 percent of stock currently in the quota management system, the lack of research data available to inform environmental decision-making has also been identified as a key concern by the environmental community. There is a widespread view that fisheries research has focused largely on a small number of commercially important fish species with little funding available for projects to assess the impacts of fishing on the marine environment.

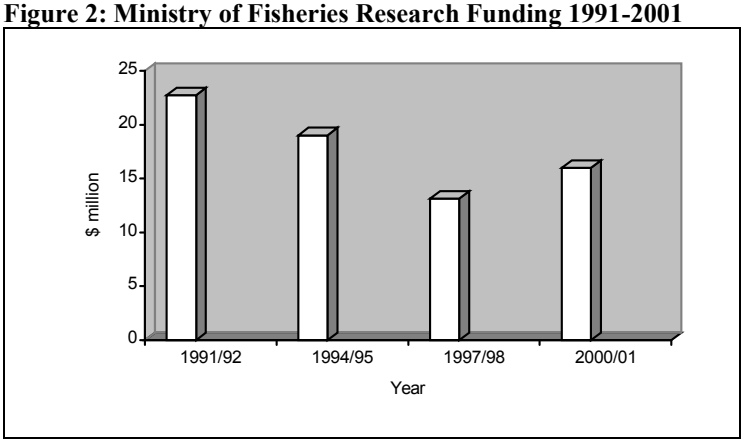
One of the main reasons identified why research has focused primarily

on commercial fish species is the way research priorities are set. Like other consultation processes under the Act, the process for identifying research priorities is limited to groups the Ministry recognises as stakeholders. The result is that the majority of stakeholder groups taking part represent the commercial fishing sector.

The need to ensure research priorities can be set and research work undertaken in an environment free from commercial influence is an important issue for environmental stakeholders. Allowing the industry to influence research priorities, undertake or contract fisheries research presents significant risks, not least in the potential for commercial capture and bias in the results. A strong view emerged during the consultation process that research should be commissioned and carried out through a process independent of commercial interests.

A related issue is the lack of secure funding for research relating to fishing impacts on the aquatic environment. Throughout much of the last decade, ECO and Forest and Bird have observed the sustained pressure from the commercial fishing sector not only to prevent research projects with an environmental focus but also to cut the Ministry's research budget.

Figure 2: Ministry of Fisheries Research Funding 1991-2001



Source: Office of the Auditor General (1999)

In 1991/92, fisheries research funding was set at approximately $23 million. By 1997/98, funding had been cut to just $13 million. Funding levels have been partially restored since, rising to $16 million in 2000/01 but still remain well below 1991/92 levels. To fully restore funding to 1991/92 levels, a budget increase of over 40% would be required.

Over the last five years, total funding on environmental projects has changed little. Funding in 1995/96 was $546,000, compared with $503,000 in 2000/01. While current year funding is budgeted to double to $1.173 million, environmental groups have often seen the actual level decline in the research finally contracted.

If we do not assess environmental impacts, we will destroy not only the resource but many other parts of the environment."

"We need [a] major increase in marine research funding through agencies that have no financial links to the industry."

"More financial resources are needed."

"Resource rentals [should] pay for research"

A key part of any environmental management strategy must be to increase significantly the amount of research funding for assessing the impacts of fishing on the aquatic environment. In particular, an increase in funding is required to improve the Ministry's scientific observer coverage in all fisheries (Tennyson, 1993). This coverage is poor in inshore, middle depth, deepwater and tuna fisheries. Observer needs to be improved so that at least 20 percent of every fishery is covered. This coverage should be provided by Ministry observers to ensure robust information is provided.

"Environmental impact assessment is essential if fishing stocks [and] ecosytem health are to be maintained"

ECO and Forest and Bird note Ward's (2001) observation on cost recovery approaches to fisheries management. Citing the example of Western Australia, where fisheries management is largely cost recovery, he notes

> *As a result of this alone, there are significant obstacles in meeting environmental obligations and management operations in support of environmental matters are not easily endorsed for funding, except to the extent that they may affect future productivity in the fishery*.

"Environmental impact assessment should be a requirement of every type of fishery"

The observation is relevant to New Zealand given the similar cost recovery system in place here. Environmental stakeholders are strongly of the view that the commercial sector, which benefits directly from access to the fisheries resource, has a responsibility to pay a proportion of the costs of research required to manage the impacts of fishing. However, the influence the industry is able to exert on funding through the current cost recovery system suggests alternative approaches are needed.

"Because of the practical limitations in the marine environment, precautionary strategies are vital, along with fully protected areas network."

A view widely held by members is that fishers should not only pay for the costs of fisheries management and research, but also for the depletion of the resource and for the environmental damage that may be caused. Payments for depletion are known as resource rentals or royalties. At each workshop, participants raised the need for resource rentals and it also arose in responses to questionnaires. At present, fishers make no payments in relation to the environmental harm they cause, even though the damage is considerable.

3.1.3 Lack of precaution and environmental assessment

"Fishers don't seem to understand that once the sea bed is scraped, material for shelter for smaller fish vanishes."

The precautionary principle is recognised internationally as a key element of fisheries management (see for example FAO Code of Conduct and the UN Implementation Agreement). The Fisheries Act contains a version of the precautionary approach, obliging decision-makers to take a "cautious approach" where information is uncertain (section 10).

Despite this obligation, management processes have tended to respond to fishing impacts only after damage to the environment has been done. The decline of the Foveaux Strait oyster fishery is an illustrative case. Similar examples can be found in the decline of the scallop fisheries, orange roughy, gemfish, rock lobster and paua.

Environmental stakeholders believe there is a need for environmental impact assessment to be undertaken to inform decision-making processes about the known and unknown threats to the aquatic environment from fishing activities.

Environmental impact assessment is recognised in the Resource Management Act as a key component of decision-making processes designed to ensure sustainable management. The absence of any comparable requirement in the Fisheries Act is a major barrier to the management of fisheries-related impacts on the aquatic environment.

A requirement within the Fisheries Act for environmental impact assessment to be carried out to determine the impacts of fishing methods and practices on the host environment would assist in ensuring decision-making is informed of the actual and potential environmental effects of fishing activities. Without this information, the ability of the Ministry to fulfil its obligation under the Fisheries Act to "avoid, remedy or mitigate any adverse effects of fishing on the aquatic environment" is severely compromised.

Fulfilling the obligations under the Act also requires effective monitoring and enforcement systems to be put in place to ensure controls intended to avoid, remedy or mitigate fishing impacts are being observed. Environmental stakeholders see monitoring and enforcement as integral components of fisheries management.

Australian Case Study
In Australia, export fisheries are required under section 303DB of the Environmental Protection and Biodiversity Conservation Act 1999 to produce an environmental assessment on the effects of fishing. This assessment is based on guidelines and terms of references prepared by Environment Australia. Any assessment is subject to public notification and submissions.

Reports have been prepared on the ecological sustainability of the Tasmanian rock lobster fishery (May 2001), Tasmanian Abalone Fishery (May 2001), Western Australia Rock Lobster fishery (October 2001), Heard and MacDonald Island fisheries. Terms of references are also available for environmental assessments of the Northern Prawn Fishery. Environment Australia has also developed a set of guidelines for ecologically sustainable fisheries. Copies of these reports and guidelines are available on the internet.

"The Ministry should prepare draft plans which should then be advertised for public submissions."

"Anyone should have a right to make a contribution to the plan."

"Policy should not be set by vested interests."

Clearly, a fisheries plan produced by the industry contains a bias of exploitation."

3.1.4 Lack of spatial policy and planning

The principle of spatial ecotype management is a key part of New Zealand's legislation relating to land-based activities. In practice, ecotype management means decisions about resource use need to take into account the likely effects on the surrounding environment. The framework of policies and plans established by the RMA is designed to make sure this occurs when decisions are made about land-based

activities.

Similar provisions exist under the Conservation Act. Under section 17D of the Act, the purpose of Conservation Management Strategies is to "implement general policies and establish objectives for the integrated management of natural and historic resources, including any species, managed by the Department under [its Acts], and for recreation, tourism and conservation purposes".

Under the Fisheries Act, however, there are no requirements to put in place policies and plans to ensure an integrated approach to management. Without this policy framework, fisheries management has tended to focus on managing single fish stocks with little recognition of how decisions impact on the other parts of the marine environment.

Table 1: Planning and public participation requirements of RMA and Fisheries Act

Requirements	RMA	Fisheries Act
Mandatory policies and plans	▪ National and regional coastal policy statements ▪ Regional policy statements ▪ District plans	None
Public participation processes	▪ Three stage public submission process. ▪ Rights of appeal to the Environment Court.	Participation generally restricted to "approved parties".

While the Fisheries Act now enables the preparation of fisheries plans, these plans are not like policies and plans prepared under the RMA. First, fisheries plans are optional whereas regional policy statements and district plans are mandatory. Second, there is very little detail in the Fisheries Act on the content of fisheries plans and what they should cover. In contrast, the scope of regional policy statements (RPSs), regional and district plans is specified clearly in the RMA. Among other things, RPSs must state the significant resource management issues of the region and the environmental results anticipated from policies and methods.

Another important difference is the limited requirements for public participation in the preparation of fisheries plans. The RMA sets out a three-stage public process for participation. There is also a further right to appeal matters to the Environment Court. In contrast, the Fisheries Act requires only that there should be consultation with "representatives" of interested groups.

One of the major differences between resource management and fisheries plans is that fisheries plans do not have to be prepared by a statutory body. The Fisheries Act says anyone can prepare a fisheries plan. However, the purpose of this provision is widely seen as being to enable the commercial sector or other extractive users to develop their own plans. Environmental stakeholders see this as similar to allowing the mining industry to write plans that control mining on conservation land or the farming industry to write regional water plans.

"There are problems of consistency of information under the RMA but it is a good starting point."

"Ministry should prepare plans – industry should have submission role - same status as public."

"QMS has given holders too strong a sense of 'property right' for what is a common property."

Concerns about Fisheries Plans have been intensified by the Ministry's declaration that the Minister will not change any provisions of fisheries plans, only approve or reject these. In trying to improve the acceptability of controls to the extractive sector – by giving them the pen, the Ministry has left New Zealand in the situation that such plans will be little more than fishers' business plans that have no public legitimacy.

The differences between conservation and resource management planning and fisheries plans highlight the lack of planning requirements in the Fisheries Act. While the Environmental Management Strategy now being prepared by the Ministry may help to address some of the gaps in the planning framework, the EMS is not a statutory document and it is not clear what status it will have in decision-making processes.

Environmental stakeholders are strongly of the view that fisheries policy and planning processes need to be reviewed, with particular reference to the processes established under the RMA and Conservation Act. There is a widely held view that Fisheries Plans should be prepared using a process similar to that for preparing plans under the RMA and other environmental legislation.

A related concern for environmental stakeholders is the lack of integration between the environmental policy and planning functions of the Ministry of Fisheries, Ministry for the Environment and Department of Conservation. This lack of integration is seen as an impediment to the development of a comprehensive approach to fisheries and marine management, diluting the responsibility for the achievement of environmental objectives. While this issue may be addressed through the Oceans Policy process, mechanisms should also be considered within the scope of the Environmental Management Strategy to address coordination between the various agencies with responsibility for the marine environment.

3.1.5 Dominance of property rights approach to management

Since the 1980s, commercial fishing access has been controlled primarily by the quota management system (QMS). The intention of the QMS was to create a "market" where fishing "rights" could be bought and sold. When the system was introduced, it was argued that quota ownership would give fishers a greater stake in the future of the fishery and act as an incentive to manage the resource sustainably. In practice, however, there is little evidence this has occurred.

The Parliamentary Commissioner for the Environment's 1999 report on the management of the marine environment concluded:

> *there is little evidence yet to suggest that [the QMS] is delivering sustainable management of fish stocks or the marine ecosystems they inhabit…The dominance of the private property rights approach has, to differing extents, excluded the values and*

"Of the seas 30% for commercial, 30% for recreational and customary and 40% for marine reserves."

"QMS [is] based on historical catches which bear little relevance to sustainability."

"The QMS was an economic model… It never was a biological model."

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Establish far more no-take marine reserves."

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"Creating [no-take] zone is best way to recognise non-commercial value"

"Rahui [are needed] to protect stocks."

If we protected 50% of our marine environment, catches from the remaining 50% would increase for both commercial and recreational fishers."

> *priorities of tangata whenua, recreational users, local residents groups and other concerned groups from policy and decision-making processes.*

Environmental stakeholders share this view. The property rights approach to fisheries management has meant commercial interests have dominated decision-making. Recognition of concerns held by environmental interests, tangata whenua and others has been minimal. In effect, the property rights approach has meant a public resource has been managed primarily for private, commercial interests.

This imbalance needs to be redressed by establishing a management framework that is able to recognise common property rights and to recognise and protect non-extractive values, uses and ecological functions.

3.1.6 Lack of protection of non-extractive use values

Environmental stakeholders see marine reserves as one of the most important mechanisms to protect non-extractive use rights and preserve the marine habitat in its natural state. To date, only 15 marine reserves have been established, protecting species in under 0.1 per cent of New Zealand's Exclusive Economic Zone. In comparison, around 30% of our land area is protected in parks and reserves.

Article 192 of UNCLOS places an unqualified obligation on states to "protect and preserve the marine environment". Fully protected marine reserves are a key tool to help reverse widespread overfishing and habitat disturbance.

There are many potential advantages of marine reserves including:

- protection of spawning populations;
- providing a recruitment source for surrounding areas;
- restocking fished areas through emigration;
- maintenance of areas of undisturbed habitat;
- protection of genetic diversity;
- insurance against management failures in fished areas;
- reduced data-collection needs;
- simplified enforcement;
- ease of public understanding and acceptance of management.

Internationally, many marine scientists are calling for at least 20% of the oceans to be protected in marine reserves by 2020. Some advocate that 50% needs to be protected to safeguard marine biodiversity from overfishing.

Most marine scientists have accepted the use of marine protected areas as a legitimate fisheries management tool. The United States National Research Council Committee on Ecosystem Management for

Ministry of Fisheries needs a culture change to ensure [it] implements all parts of the Act, including the "green" principles."

Fisheries should be retained as a public resource, with fishers paying an effective royalty on catch and by-catch."

"The ocean belongs to all of us. It can't be owned.

Sustainable Marine Fisheries (1999) recommended that establishment of marine protected areas adjacent to all the US coasts, including in highly productive areas. The committee noted that calls for protecting 20 percent of potential fishing areas provided a worthwhile reference point.

This consultation process revealed significant support for at least 20% of our oceans to be protected in marine reserves. Many indicated support for between 30-50% to be protected (see for example Yoklavich 1998, Lauck et al 1998). In addition, there was support for the use of customary fishing areas (mataitai, taiapure and rahui) to complement coastal marine reserves.

Marine Reserves Produce Enormous Benefits

Over 150 of the world's leading marine scientists have called for the immediate establishment of networks of marine reserves to replenish depleted seas.

At this year's American Association for the Advancement of Science (AAAS) Meeting past president Dr. Jane Lubchenco released a scientific consensus statement declaring that there is now compelling scientific evidence that marine reserves conserve both biodiversity and fisheries, and could help to replenish the seas.

"All around the world there are different experiences," says Dr. Lubchenco. "But the basic message is the same: marine reserves work, and they work fast. It is no longer a question of *whether* to set aside fully protected areas in the ocean, but *where* to establish them. We urge the immediate application of fully protected marine reserves as a central oceans management tool."

At the AAAS meeting the results of a three-year scientific study into marine reserves was presented. The study, co-ordinated by the National Centre for Ecological Analysis and Synthesis (NCEAS), University of California, Santa Barbara, provided additional scientific evidence of the benefits of marine reserves.

"The results are startling and consistent," states Dr. Robert Warner of the University of California, Santa Barbara. After only 1-2 years of protection, results showed:

- population densities were on average 91% higher
- biomass was 192% higher
- average organism size was 31% higher
- species diversity was 23% higher.

The size and abundance of exploited species also increases in areas adjacent to reserves. Reserves serve as natural hatcheries, replenishing populations regionally by larval spillover beyond reserve boundaries. In 1994, three large areas totalling 17,000 km^2 in the Gulf of Maine were closed to all fishing methods that put groundfish at risk (this is three times the total area in marine reserves in New Zealand). Coincidentally, scallops flourished in the undisturbed habitat. Within five years their populations rebounded to 9 to 14 times their density in fished areas. Monitoring showed scallop fishers hugging the edge of the closed areas, benefiting from high catches as a result of adult movement and export of scallop offspring on ocean currents.

Marine reserves differ from parks on land because most marine species disperse through the water as larvae or spores, moved by tides and currents. Dispersal distances of 20 to 50 kms are not uncommon and 500 to 1000 kms is possible in some cases due to currents. "You want to design reserves so that they have a spillover effect in helping replenish the ocean beyond the protected area," says Dr. Steve Palumbi of Harvard University. "Well-designed networks are the key."

Using new knowledge of larval dispersal patterns, scientists can determine the optimal span, spacing and size of the pieces. The NCEAS studies demonstrate that networks of fully protected marine reserves linked ecologically (through larval dispersal) and physically (through currents) are much more likely to achieve a greater range of benefits rather than the current tendency to establish single isolated reserves.

The scientists also presented the results of a new computer-based tool that can map and design reserve systems for fishery managers across the U.S. and the world. "Conservationists can be reassured that marine reserves *are* protecting biodiversity, and while fishermen may lose access to some areas, they will reap the benefits outside the reserves. The overall lesson is that all stakeholders can be served by well designed networks of marine reserves," states Dr. Jane Lubchenco.

3.2: Rank environmental stakeholders' concerns about the management of fisheries-related impacts on the aquatic environment.

3.2.1 Ranking of problems
Table 2 shows the ranking respondents gave to the concerns identified above.

Table 2: Ranking of problems

Problem	**1** Unimportant	**2**	**3** Important	**4**	**5** V important
Lack of public participation	0	1.9	**19.8**	**18.9**	**59.4**
Lack of information and research	0	0	**4.6**	**8.2**	**87.3**
Lack of environmental assessment	0	0	**7.1**	**8.0**	**85.0**
Lack of integrated planning	0	0	**5.6**	**17.8**	**76.6**
Failings of property rights approach	1.9	0.9	**13.2**	**19.8**	**65.1**
Lack of protection on non-extractive uses values	0	1.8	**2.7**	**9.9**	**85.6**

3.3: Identify the appropriate balance between protection and use of fishery resources required to address these concerns.

3.3.1 Restoring the Balance

Over the last 20 years, commercial fisheries have expanded to cover greater areas and depths and a wider range of species. Recreational fisheries have also grown in size, targeting a wider range of species. The result is that most areas of New Zealand's coastal waters and EEZ are open to fishing.

A balance now needs to be restored between protection and use of fishery resources.

3.3.2 International Obligations:
New Zealand has a range of international obligations that are relevant to marine management. These obligations mean New Zealand:

- has an obligation to protect and preserve the marine environment;
- is committed to an eco-system based approach to managing the use of natural resources;
- is committed to the precautionary approach to minimising risk to the environment;
- is committed to the concept of inter-generational equity.

3.3.3 Ecosystem Management
To fulfil New Zealand's international obligations and restore the balance between protection and use of the marine environment, an ecosystem approach to fisheries management needs to be developed.

Increasingly, ecosystem management is being recognised as the way forward for fisheries. There is now a growing body of evidence documenting the deficiencies of conventional management approaches that focus on single species management. Ecosystem-based management presents an alternative model that takes an holistic approach, recognising the complexity of marine environments and the need for precaution in the face of uncertainty.

Through consultation with members, ECO and Forest and Bird have identified a set of key elements for ecosytem management.

Key Elements of Ecosystem Management

1. Spatial, ecotypes and impacts policy and planning

A spatially integrated approach to management is required to ensure decision-making recognises the interrelationships between and within marine ecosystems and cumulative impacts.

2. A precautionary approach

The precautionary approach calls for "risk-averse" decisions that recognise the uncertainty involved in decisions about complex marine ecosystems. Where information is uncertain and effects are likely to be long-term or irreversible, the benefit of doubt should be given to the environment.

3. Open public participation processes

Open public processes are required to ensure decision-making takes into account public views and community values. To ensure access to decision-making processes, barriers to participation, including lack of funding, need to be addressed.

4. Independent monitoring and research

Decision-making needs to be informed by independent monitoring and research to ensure the environmental impacts of fishing can be managed. Adequate funding needs to be made available to ensure monitoring and research functions are not compromised.

5. Environmental impact assessment

Decision-making needs to be informed by an assessment of the actual and potential environmental impacts, including an assessment of any impacts that may arise over time.

6. Protection of non-extractive use values

Management processes need to recognise and provide for non-extractive use values to protect marine ecosystems from the impacts of fishing through, for example, establishing a comprehensive area of marine reserves and protected areas.

7. Recognition of common property right in the ocean

Fisheries management must recognise the common property right in the oceans. This right means access to marine resources should not be preserved for any one group. Management processes need to recognise and provide for all interests.

8. Reversal of the onus of proof

Risk averse policies cannot be expected to be implemented until the burden of proof is placed on fishers to prove they do not cause damage (Dayton, 1998). "If society's environmental needs are to be protected so that future generations can also enjoy, learn, and profit from marine ecosystems, this legal burden of proof must be applied to our marine resources so that those hoping to exploit them must demonstrate no ecologically significant long-term changes" (Dayton 1998).

9. Treaty of Waitangi

Fisheries management processes need to recognise the State's obligations to tangata whenua under the Treaty of Waitangi.

3.3.4 Improving fisheries management - putting principles into action

ECO and Forest and Bird have identified key changes that need to be made to fisheries management. These changes include:

- Retaining government control and administration of fisheries management, research, planning and enforcement;

- Introducing requirements for the assessment of the host environment and the environmental impacts of fishing;

- Ensuring fisheries are managed according to the precautionary principle so that:

  a) depleted fish stocks are rebuilt through more effective and timely controls or area closures;
  b) all fish stocks are managed to ensure populations do not fall significantly below those that maintain trophic and other ecosystem relationships;
  c) fishing is strictly limited or not permitted for fish stocks for which information on populations levels or fishing impacts is absent, seriously inadequate or indicates significant adverse effects.

- Ending fishing practices that cause significant adverse effects on the marine environment including an end to the use of set nets and bottom trawls;

- Reducing seabird and marine mammal deaths resulting from fishing to negligible levels approaching zero;

- Removing barriers to public participation and providing assistance to empower the public to take part in fisheries processes;

- Developing a system of representative marine reserves and other controls to avoid, or mitigate the effects of fishing on the marine environment.

3.3.5 Fishing impacts - priorities for management

To identify management priorities, ECO and Forest and Bird asked members to rank fisheries-related impacts on the aquatic environment in order of importance. Table 4 shows the results.

There are many issues which the Ministry has yet to adequately respond to new information on the impacts of fishing on the marine environment. These include:

- Extension and permanent entrenchment of the closure in Spirits and Tom Bowling Bay based on the more recent NIWA report for the Ministry of Fisheries (Cryer et al 2000).
- Measures to maintain marine biodiversity and to avoid, remedy or mitigate the impacts of the scampi fishery on benthic species (see pages 56-58 of Cryer et al 1999).
- Measures to maintain marine biodiversity and to avoid, remedy or mitigate the impact of oyster dredging in the Foveaux Strait (Cranfield, Michael and Doonan 1999).
- Measures to maintain marine biodiversity and to avoid, remedy or mitigate the impact of fishing on the bryozoan thickets off Otago Peninsula (Batson and Probert, 2000).
- Measures to maintain marine biodiversity and avoid, remedy or mitigate the adverse impacts of commercial scale bottom impacting methods including trawling and dredging on benthic species (see *Conservation Biology* December 1998 (Vol 12, No 6).

Table 4: Fishing impacts - priorities for management

Issue	1 Low	2	3	4	5 High
Depletion of fish stocks	0	0	**0.9**	**0.9**	**96.3**
Marine farming	1.9	1.9	**19.4**	**23.3**	**53.4**
Bycatch					
▪ Marine mammal bycatch	0	1.9	**3.7**	**13.9**	**79.6**
▪ Seabird bycatch	0	0.9	**2.8**	**16.7**	**78.7**
▪ Invertebrate bycatch	0	1.0	**8.7**	**16.4**	**73.1**
▪ Non-target fish species	0	1.0	**3.9**	**15.4**	**78.9**
Fishing methods					
▪ Trawling on seamounts	0	0	**1.9**	**6.5**	**91.6**
▪ Trawling on the seafloor	0	0.9	**5.7**	**14.2**	**79.3**
▪ Dredging for shellfish	0	0	**7.6**	**13.3**	**79.1**
▪ Longlining	1.9	1.9	**8.7**	**21.4**	**66.0**
▪ Setnetting	0	0	**4.8**	**21.9**	**73.3**

The Ministry has yet to finalise a National Plan of Action on Reducing the Incidental Catch of Seabirds in Fisheries or on the Conservation and Management of Sharks or to respond formally to the FAO Code of Conduct on Responsible Fisheries. The United States has an action plan for implementing Code of Conduct and has prepared NPOAs on Seabird Bycatch and on Sharks.

STUDY ANALYZES FISHING IMPACTS ON OCEAN FLOOR
Rhode Island, July 5, 2001
The type of fishing gear used to catch bottom dwelling fish and shellfish has a "significant effect" on the degree of disturbance to the sea floor environment, a new study reveals. Fishing gear often disturbs both the seabed and the animals living in or on it. A team of international scientists, including University of Rhode Island fisheries oceanographer Jeremy S. Collie, analysed data from a number of separate fishing impact studies to learn which variables affect the amount of damage caused by bottom fishing. The team found 57 different observations from 39 separate studies on the effects of fishing disturbance on seafloor organisms around the world. The results of Collie's meta-analysis, which is the summary of multiple, independent studies to detect general relationships, are reported in the "Journal of Animal Ecology."
The study reveals that intertidal dredging has the worst impact, followed by scallop dredging and intertidal raking. The largest negative impacts occurred in habitats composed of slow growing species such as sponges and corals. "Despite our efforts to predict the outcome of fishing activities for existing seafloor communities, we are often unable to determine the original composition of the fauna because data gathered prior to the era of intensive bottom fishing are sparse," said Collie. "This is an important consideration because recent analyses of the few existing historical datasets suggest that larger bodied fish and invertebrates were more prevalent prior to intensive bottom trawling."

3.4 Identify opportunities for environmental stakeholders to work with tangata whenua and other fishery stakeholders to achieve shared environmental goals.

To identify opportunities to work with others, ECO and Forest and Bird asked members the following three questions:

- Who should be involved in identifying environmental goals for fisheries management?
- Should there be any restrictions on who can take part?
- To ensure all identified interests can participate, what processes and resources are required?

To ensure maximum 'ownership' of decisions… all interested/affected parties should participate."

Reflecting the need to ensure widespread public input into decisions regarding fisheries management, members expressed a strong preference for an open process, accessible to everyone who wants to take part.

To provide opportunities for widespread public participation, a clear preference emerged for the establishment of public submission and hearing processes, similar to the RMA. There was also marked support for the development of a "national fisheries policy statement", similar to the New Zealand Coastal Policy Statement. The national policy statement process was identified as providing an opportunity for all communities of interest to participate in determining policies for future fisheries management.

The ordinary public are "environmental stakeholders" and "fishery stakeholders".

The predominant view expressed during consultation was that all New Zealanders are "stakeholders" and should have the opportunity to participate in decision-making and in identifying and working towards the implementation of shared environmental goals.

""All New Zealanders are stakeholders."

As noted above, unlike other legislation such as the Conservation Act and the RMA, the Fisheries Act does not provide for public participation as a matter of course. This is widely seen by environmental stakeholders as an anomalous situation that needs to be addressed.

We need a central government agency that can advise and assist NGOs and the public who want to be involved."

It is also at odds with New Zealand's commitments to public participation made under the Agenda 21. Agenda 21 contains specific obligations to facilitate public participation, including obligations to:

- *[ensure] access by the public to relevant information, facilitating the reception of public views and allowing for effective participation;*

  and

- *[provide] mechanisms for appropriate involvement of individuals and groups in the development and enforcement of*

laws and regulations on environment and development.

Under the present fisheries management framework, very few opportunities exist to enable groups and individuals to work together to identify or achieve shared environmental goals. However, for fisheries management to be successful, full account needs to be taken of the multiple sets of interests and values that exist within the community. In order to do this, processes and resources are required that ensure there are opportunities for divergent interests to participate. While this will require additional investment from the government, there is significant scope to achieve substantial environmental benefits from improved decision-making in the medium to long term.

4. Where to from here?

This section discusses key elements of an EMS and identifies the "next steps" needed to progress development of the Strategy.

4.1 What will an Environmental Management Strategy for fisheries management look like?

The EMS will need to address institutional, organisational and attitudinal changes required to improve fisheries management. ECO and Forest and Bird suggest an EMS for fisheries management should include sections that address:

1 Management objectives (targets), ethos, criteria and approaches
2 Management instruments and mechanisms;
3 Management institutions and responsibilities;
4 Getting there.

These elements are discussed below.

4.1.1 Management objectives (targets), ethos, criteria and approaches

It is clear from the consultation undertaken that there is widespread concern about the stock-focussed approach to management currently taken by the Ministry.

The EMS needs to clarify:
- what is the "asset" being managed?
- what is the objective of management?
- for whom are fisheries being managed?

Differing answers to these questions underpin several of the conflicts in fisheries management. Ultimately, the community will determine which of the possible answers to these questions is legitimate. If the Ministry's management objectives do not accord with those of wider society, then the Ministry's mandate will come into question.

The consultation undertaken by ECO and Forest and Bird shows respondents do not consider that simply conserving stocks or icon species is sufficient as environmental management objectives. Damage to benthic structures and assemblages and to seamount faunal composition emerged as key issues of concern: it is not just seabirds and marine mammals that should be the object of management attention or response. Our constituency is clear that it is ecosystem health that matters, not a few species that qualify as "charismatic megafauna" or "icons".

4.1.2 Criteria

Criteria provide the grounds or basis for assessing policy options and proposals. Some criteria for fisheries management are set by the Fisheries Act 1996. However, while the Act gives some specificity, more will be required.

Criteria that should form part of the EMS include:

1 Effectiveness at providing environmental management according to the criteria in the Fisheries Act and other ecological criteria (maintenance of abundance, range and diversity of species; assemblages, colonies and ecosystems; maintenance of biophysical processes and ecological functions).

2 Public legitimacy and inclusion of the public in decision making and planning.
Public participation is fundamental to participatory democracy. At a more technical level, the environment is a multifunctional resource that produces a mix of rival and non-rival services, ecological functions and commodities. To regulate and control access to these services, collective decision making processes are required. Management processes that restrict access to planning and decision-making will lack legitimacy. Therefore, processes must provide for open public access.

3. Capacity to cope with limited information;

4. Capacity to give incentives for the provision of accurate, untainted and unbiased information;

5. Degree of precautionary approach;

6. Equity to the future;

7. Embodiment and implementation of the Principles outlined above.

8. Other criteria
Trevor Ward notes that the strategy he proposes rests on three propositions:

   a. *The need to ensure fishery impacts are acceptable to the broader community and that the benefits of continued fishing are not outweighed by environmental consequences;*

   b. *Responsiveness to changed information and changed understanding of the environment and other aspects of the world;*

   c. *Application of an ecological risk assessment process conducted with wide participation.*

4.1.3 Approaches

Ecosystem approaches

Trevor Ward's paper and other international literature make it clear that there is a choice of approaches to fisheries management.

It is clear from this report that there is strong demand for the Ministry to move beyond fish-stock management to an ecosystem approach to fisheries management. Developing

ecosystem-focussed approaches is far further advanced in Australia and various other countries than it is here. ECO and Forest and Bird believe there is a need for a workshop to further explore the elements of ecosystem management. We note some work in this area has been done by the Ministry for the Environment.

Decision aids, holistic approaches and strategic and risk-based frameworks

There is a range of decision aids for environmental management yet few of these are used by the Ministry of Fisheries (see Dale and English, 1998 and O'Brien, 2000).

Responses to the workshops and questionnaire lend strong support to the idea that the Ministry could use other assessment methods and decision aids for better environmental outcomes. Some of these methods are community based (such as community mapping techniques), while some are quantitative. Many require broad-brush use of information rather than highly sophisticated models that demand unavailably large amounts of information. There is a strong risk of "misplaced concreteness" if some kind of sophisticated risk modelling is done when in fact the information for the necessary judgements is not at hand.

An example of where broad based theory can help is the basic bioeconomic rule that long lived, slow-growing species are likely to be "mined" when discount rates are high. This rule can be used to predict which fish stocks are likely to come under most pressure and can be used to direct management effort to such stocks.

There are also decision processes that are in use in other environmental management contexts and are explained in the literature and/or are familiar to environmental management and resource management professionals that could be used in fisheries management but which are not (Dale and English, 1998).

Trevor Ward details some of these but others are already in use in the context of Conservation Management Strategies, in resource management out to 12 nm and in other contexts.

Risk Assessment

It is clear that a motivating reason for having an EMS is the series of risks in fisheries management. These include risks relating to our lack of understanding of ecosystems and our impacts on them, natural variability of biological systems and unexpected impacts or hidden impacts by people on fisheries and their host environment.

There are considerable risks of inequity between the present and the future, between extractive and non-extractive users and across other dimensions. There is also financial and economic risk, risk to life and limb, risks to efficiency, and risks to Treaty relations.

However, risk analysis is not necessarily the answer and is certainly not the whole answer. Many environmental management specialists suggest that risk assessment is not a useful tool since it masks uncertainty with spurious precision. Much risk assessment is a sophisticated "con" job – not always deliberate – that has the effect of excluding important values and participants. It can rapidly become a device for excluding those with legitimate concerns and those with questions that are not admitted in the process or design of risk assessment. Such assessments rarely challenge whether the activity should take place. At best such assessments mislead with "misplaced concreteness" and, commonly, hidden assumptions.

Debate over risk assessment design can provide fertile ground for delay in decisions to reduce damage. Manipulation of assumptions, specifications, values and results are useful for those who seek to stave off decisive action to reduce environmental damage. Risk assessments are

often promoted by those who see their value in removing focus from the question of whether the activity is suitable or desirable at all. They can be, and often are, portrayed as rigorous and scientific but they usually embody so many contestable assumptions, shaky data and omissions that they are neither rigorous nor scientific.

Ludwig, Hilborn and Walters (1993) identify how optimistic risk assessments form a consistent pattern in fisheries management. Such optimistic assessments are masked by natural variability, professional scientific obfuscators hired by fishing interests, exploitation of the scientific tradition of systematic doubt and ecosystem complexity.

O'Brien (2000) comments "risk assessment is primarily used to defend unnecessary activities that harm the environment or human health". O'Brien recommends instead that "Alternatives Assessment" be done where discussion of a range of alternatives and the advantages and disadvantages of each is explored. O'Brien gives a candid if not cautious assessment of risk assessment and its misuses.

Consideration of alternatives is an essential part of better environmental management but it is not required by statute in the Fisheries Act. It is in the RMA (both in relation to control options (section 32) and in relation to environmental assessment).

Attention to incentives, economic drivers and appropriate economic analysis
Fisheries management must pay close attention to ecological economic theory and to institutional analyses from both economics and political theory. It will not be enough to stick with neoclassical economic theories or the narrowly financially focussed resource economics that has characterised the fisheries economics that has sometimes been done for the Ministry.

Recognition of natural capital, the problems of irreversibility of impacts and the non-substitutability of artificial capital for natural capital (e.g. of roads for ecosystems) should all be part of the EMS. The Safe Minimum Standard and other analyses could be applied but only if the assumptions are carefully debated and crafted with ecological expertise to determine possible scenarios.

It will not be enough or legitimate to simply use market values, to consider a narrow range of options or to assume away the importance of existence, bequest and option value and the value of ecological services. Economic drivers of behaviour, the need to recognise the divergence of high discount rates for private decisions from social decision rules and discounting, especially of natural capital, need to form part of the EMS.

4.1.4 Management instruments and mechanisms

In considering the choice of management instruments and mechanisms, the Ministry will need to apply criteria.

Our consultation has drawn out a number of suggestions referred to above in the paper and there are further suggestions in the international literature, from various recent conferences and from the paper by Trevor Ward.

We do not have the time and space to assess them here but we think it is worth a partial discussion. Any paper by the Ministry will need to canvass a mix of instruments and options, with evaluation of alternatives and considerations of their advantages and disadvantages according to the criteria that are identified and then also according to other criteria that may become apparent in the consideration of the options.

Mechanisms that need to be considered include:

- How fisheries level measures can be designed and implemented against the fabric of ecotype and spatial environmental management strategies and plans;
- Ecotype and spatial level assessment and impacts avoidance and management measures and requirements;
- Cumulative impacts assessment, monitoring and evaluation techniques;
- Gear, method and impacts documentation, strategic assessment and controls;
- The role, design, implementation and governance of no-take protected areas and how other forms of protection should interact with these.
- Reversal of the burden of proof.

Certification Schemes
Some other mechanisms currently being promoted are less suitable, namely ISO14000 and MSC. It is clear from certifications in New Zealand under these schemes that they are not reliable standards to achieve environmental protection. On the basis of our experience with these certification schemes, we think that in their application they set standards too low and are too keen to lower standards in order to achieve a portfolio of certifications. The Forest Stewardship Council has similar problems. We note that even Trevor Ward, a member of the hoki fishery assessment panel, acknowledges that the MSC certification tolerates substantial environmental damage. There may be issues in MSC requirements but we do not agree that MSC or ISO 1400 are reliable models. Such certification schemes would require careful attention to institutions and who sets standards how and who has voice.

4.1.5 Management institutions

Management of fisheries is necessary because fisheries are a common pool resource that in harvest are rival. Exclusion must be by a management authority with designed institutions.

The role of government
Government involvement is required because the environment and the fish, if owned by anyone, are owned by all. Government has authority to control access and the terms of access. Exclusion of effort is needed to protect stocks, control environmental impacts and to prevent the dissipation of rents through inefficiently high levels of efforts (which are accompanied by increasing costs per unit of effort).

Quota management associations appear to have been adopted on the basis of the Theory of Clubs and contracting. No management club will be able to counter-act the iron law of discounting which will mean that there will always be pressure to "mine" slow growing long lived fish and others with certain revenue and cost characteristics.

From society's point of view, quota owners will also be unlikely to take account of the full set of services and ecological functions that society's members value, since for many fishers the extractive value of fish is all that enters into their private calculus. This was understood intuitively by many of our respondents, and formally by a few.

Ostrom has observed the conditions for successful and unsuccessful management of common pool resources by communities. Our assessment is that the conditions that she observes as necessary will not apply for New Zealand fisheries except perhaps in a few small and tightly knit communities. Some local fisheries such as rock lobster and shellfish might be able to succeed with community management of fisheries but this will not work for most.

When there is not agreement on the objective of management, "club" management is unlikely to be successful. Such failure of agreement is endemic to New Zealand fisheries management with environmental, commercial, recreational and customary Maori goals in various forms of disagreement. For this reason too, fisheries management should be a function of government not of industry clubs.

An environmental directorate or division within the Ministry of Fisheries
This arm of the Ministry of Fisheries would have the task of doing many of those things suggested by Trevor Ward in his paper. This is a proposal that we think the Ministry needs to take seriously. We do not think that the attempts to inject some environmental element into the Ministry's work have been sufficiently successful to date. Trevor Ward's suggestions, however, seem to us to need some modification. For example, we suggest Ward has underestimated the number of people required; a minimum of between 8-10 people would be needed rather than one manager with a couple of assistants.

Environmental management advisory groups
Such groups are a good idea, but not if these are simply particular to individual fisheries. Environmental management groups should be organised around environmental types, places and problems.

Public input
The Ministry should hold the pen on environmental and fisheries plans, not extractive interests. Those interested should be included and in the case of those lacking in resources, they should be assisted to participate. The equivalents of Conservation Management Strategies and Conservation Boards should be established with independent parties appointed on nominations from the public in predominance but some representatives of particular interests.

4.2 Getting There:

We suggest that in the New Year, the Ministry hold a 2-3 day workshop of people with an interest in working through a range of the issues that need to be sorted through in designing the EMS.

We recommend that this workshop has a cast consisting of:

1 Overseas speakers who can give presentations and advice on EMS in order to get the New Zealanders thinking creatively, and to break up the traditional fisheries discussion dynamics.

2 Officials from M Fish, MfE, DoC, TPK and regional councils and some regional councillors.

3 Academics/specialists from the fields of environmental management, GIS, planning and marine management.

4 Representatives from each of the "approved party" environmental organisations who know how the system works now.

5 Representatives from SeaFic and ToWFC, plus 2-3 thoughtful people from extractive interests such as customary Maori, recreational and commercial areas.

6 Maori interests with skills in planning, fisheries and/or environmental management.

7 Representatives from the workshops that we ran who could bring useful regional or other perspectives.

It will be important that the balance of the workshop is such that there is a reasonable collection of people who are not already in fisheries debates. Numbers should be big enough to allow subgroups to work effectively but not so big that thoughtful plenary discussion is unworkable.

The workshops should be funded by Mfish (airfares, venue, facilitator and other costs). To keep costs down, Mfish should encourage participants to find billets rather than hotel accommodation.

We suggest three days will be essential to work through the issues, as well as hear stimulating presentations from various invited overseas speakers.

We also suggest Mfish should take advice from MfE which has run a series of workshops on environmental indicators and related issues.

5.0 Recommendations

Recommendations on the Ministry's Environmental Management Strategy:

1. The Strategy should provide the overview of the environmental management approach for the Ministry of Fisheries. Any management plans, regulations and other measures should be subject to the strategy.
2. The Ministry should adopt best practice measures to avoid or mitigate the effects of fishing on the aquatic environment.
3. Decisions regarding fisheries management must be made through an open process that fosters collective decision-making and recognises divergent interests and values.
4. Fisheries policy and planning processes need to be reviewed, with particular reference to the processes established under the Conservation Act and RMA.
5. The Ministry should adopt the following principles for environmental management:
   - Spatial, ecotypes and impacts policy and planning;
   - A precautionary approach
   - Open public participation processes
   - Independent monitoring and research
   - Environmental impact assessment
   - Protection of non-extractive use values
   - Recognition of common property right in the ocean
   - Reversal of the onus of proof
   - Protection of taonga recognised under the Treaty:

6. A key part of any environmental management strategy must be to significantly increase the amount of research funding to assess impacts of fishing on the aquatic environment.
7. The Strategy should adopt the following key approaches to management:

- Retain government control and administration of fisheries management, research, planning and enforcement;
- Introduce requirements for the assessment of the host environment and the environmental impacts of fishing;
- Ensure fisheries are managed according to the precautionary principle so that:
  a) depleted fish stocks are rebuilt through more effective and timely controls or area closures;
  b) all fish stocks are managed to ensure populations do not fall significantly below those that maintain trophic and other ecosystem relationships;
  c) fishing is strictly limited or not permitted for fish stocks for which information on populations levels or fishing impacts is absent, seriously inadequate or indicates significant adverse effects.
- End fishing practices that cause significant adverse effects on the marine environment including an end to the use of set nets and bottom trawls;
- Reduce seabird and marine mammal deaths resulting from fishing to negligible levels approaching zero;
- Remove barriers to public participation and provide assistance to empower the public to take part in fisheries processes;
- Develop a system of representative marine reserves and other controls to avoid, or mitigate the effects of fishing on the marine environment.

8. Establish an Environmental Directorate or Division within the Ministry of Fisheries: A strong and sizeable environmental directorate is required.

9. Establish Environmental Management Advisory Groups organised around environmental types and places and problems.
10. Hold a two to three day workshop of people with an interest in working through the issues that need to be addressed in designing the EMS.

We hope these suggestions are useful. Please contact us for further discussion.

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APPENDICES

Appendix 1: International Obligations

1. The *United Nations Convention on the Law of the Sea* (UNCLOS) is a framework regime for all marine management including fisheries, mining, marine pollution and structures. The Convention is a key international obligation under section 5 of the Fisheries Act. Kimball (1995) describes the environmental obligations of UNCLOS.

2. The *Convention on Biological Diversity* (CBD) includes a number of articles relevant to fisheries management including article 8 (In-situ Conservation) and article 10 (Sustainable Use of Components of Biological Diversity). This Convention is relevant to section 5 of the Fisheries Act. Glowka et al (1994) describe the provisions and obligations of the convention. The Biodiversity Strategy is relevant to section XXX of the Convention.

3. The *UN Agreement for the Implementation of the United Nations Convention on the Law of the Sea of 10 December 1982 relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks*, includes provisions in Part II (Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks) and Annex II (Guidelines for the Application of Precautionary Reference Points in Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks) relevant to all fisheries management. It also includes provisions to conserve non-fish species including seabirds. Section 5 sets out the requirement for precautionary management.

The *Rio Declaration 1992* and *Agenda 21* (particularly chapter 17) are also relevant. For example, Rio Declaration principle 15 on the precautionary approach has become widely accepted.

The *FAO International Code of Conduct for Responsible Fisheries* 1995 includes objectives and general principles of fisheries management; data gathering and management; the precautionary approach and fisheries research.

The *Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) 1973* controls international trade in endangered species. The Trade in Endangered Species Act 1989 incorporates this Treaty into New Zealand law.

The *Convention on the Conservation of Migratory Species of Wild Animals* (the Bonn Convention) includes measures to conserve migratory animals including seabirds. The regional agreement on albatross and petrel conservation is a relevant fisheries management.

The *Convention Concerning the Protection of the World Cultural and Natural Heritage* (the World Heritage Convention). The Sub-Antarctic Islands and their surrounding 12 nautical miles have been declared a world heritage site.

The *Convention for the Protection of Natural Resources and the Environment of the South Pacific Region* (Noumea Convention) includes measures to control pollution from vessels and land-based sources, disposal of wastes and specially protected areas. This Convention applies to the NZ EEZ.

Table 4: Examples of International Obligations

	Signed	Ratified/ Acceded	Domestic Law	Lead Agency
Bonn Convention - Convention on the Conservation of Migratory Species of Wild Animals, 1979	-	Yes	No	DoC
Convention on Biological Diversity, 1992	Yes	Yes	No	DoC/MFAT
CCAMLR - Convention on the Conservation of Antarctic Marine Living Resources, 1980	Yes	Yes	Antarctic Marine Living Resources Act, 1981	MFAT/Ministry of Fisheries
CCSBT - Convention on the Conservation of Southern Bluefin Tuna, 1993	Yes	Yes	Fisheries Act	Ministry of Fisheries
Driftnet Convention - Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific 1989	Yes	Yes	Drift net Prohibition Act	Ministry of Fisheries
Noumea Convention - Convention for the Protection of the Natural Resources and Environment of the South Pacific Region, 1982	Yes	Yes	Partial – Maritime Transport Act	MFAT/DoC
Agreement for the Implementation of the Provisions of the UNCLOS relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, 1995	Yes	No	Fisheries Act 1996 (Amendment No 2)	Ministry of Fisheries
RAMSAR – Convention on Wetlands of International Importance, 1971	Yes	Yes	No – only protected from mineral activity in Crown Minerals Act 97	DoC
World Heritage - Convention Concerning the Protection of the World Cultural and Natural Heritage, 1972	Yes	Yes	No	DoC
UN Convention on the Law of the Sea, 1982	Yes	Yes	Partial - UNCLOS Act 1996	MFAT/MFish/MoC

The statutes of *IUCN - World Conservation Union* are relevant. New Zealand is a state member of IUCN and is represented by the Department of Conservation. At the IUCN World Conservation Congress that occurs every three to four years, resolutions are passed which are relevant to marine management. The last four congresses have adopted resolutions on fisheries management, marine reserves, fisheries by-catch and threatened marine species.

Appendix II: USA ECOSYSTEM PRINCIPLES, GOALS AND POLICIES[2]

There are two requirements for managing human interactions with marine ecosystems. One is to develop an understanding of the basic characteristics and principles of these ecosystems—what patterns they exhibit and how they function in space and time. The second is to develop an ability to manage activities that impact marine ecosystems, consistent with both their basic principles and with societal goals concerning the kinds of behaviour we would like ecosystems to exhibit (i.e., health and sustainability).

This section lists eight basic ecosystem principles (Principles) and their parallels in human systems that are part of marine ecosystems. A discussion of societal goals (Goals) for ecosystem-based management follows. Finally, a list of general management policies (Policies) to achieve the Goals is provided.

BASIC ECOSYSTEM PRINCIPLES

Marine ecosystems are complex, adaptive systems composed of interconnected groups of living organisms and their habitats. Living organisms are constantly adapting and evolving to their environment (both to the physical environment, which varies on multiple scales, and to other living organisms with which they co-exist); this evolution leads to complex, sometimes chaotic dynamics. Marine ecosystems are generally extensive and open. Their fluid environments are subject to variability in both local and remote inputs of energy (a consequence of physics operating on many spatial and temporal scales) which may dominate such systems. Highly variable and chaotic dynamics of living resources are often observed as well. Today, humans are a major component in most ecosystems. The human component of the ecosystem includes the humans themselves, their artifacts and manufactured goods (economies), and their institutions and cultures. The human imposition of fishing mortality, at rates often higher than natural mortality, can have major impacts not only on targeted species but also on the ecosystem itself. The following eight Principles have analogs in both the human and nonhuman aspect of ecosystems:

1. The ability to predict ecosystem behaviour is limited. Uncertainty and indeterminacy are fundamental characteristics of the dynamics of complex adaptive systems. Predicting the behaviours of these systems cannot be done with absolute certainty, regardless of the amount of scientific effort invested. We can, however, learn the boundaries of expected behaviour and improve our understanding of the underlying dynamics. Thus, while ecosystems are neither totally predictable nor totally unpredictable, they can be managed within the limits of their predictability.

Properties characterizing marine ecosystems may vary within wide bounds on decadal and longer time scales. For example, El Niño events and decadal climate changes may displace species, restructure communities and alter overall productivity in broad oceanic areas. Other phenomena, sometimes operating on smaller time scales, may precipitate regime shifts characterized by major fluctuations in constituent species (Steele 1996), but our ability to predict such events is only now evolving (Langton et al. 1996) and will always be shrouded in a degree of uncertainty. Nevertheless, management policies can be guided by the broad understanding we possess of marine ecosystem boundaries and production potential limits. The ability to predict human behaviour in fishery systems is also limited, but evolving. Many fishermen pass through rounds of fishing in regular annual patterns, markets respond in

[2] From: NMFS Ecosystem Principles Advisory Panel (1998) Ecosystem-based Fishery Management. A Report to [US] Congress by the Ecosystem Advisory Panel. 54p.

predictable ways to price changes, and fishermen often have predictable responses to policy proposals or regulatory changes. Fisheries systems respond to global market trends and economic changes, social preferences and philosophies. The ability to describe, explain and predict these human behaviours, although the behaviours vary according to circumstance, is increasing with the growing body of social scientific data and information on fishery systems.

2. Ecosystems have real thresholds and limits which, when exceeded, can effect major system restructuring (Holling and Meffe 1996).
Ecosystems are finite and exhaustible, but they usually have a high buffering capacity and are fairly resilient to stress. Often, as stress is applied to an ecosystem, its structure and behaviour may at first not change noticeably. Only after a critical threshold is passed does the system begin to deteriorate rapidly. Because there is little initial change in behaviour with increasing stress, these thresholds are very difficult to predict. The non-linear dynamics which cause this kind of behaviour are a basic characteristic of ecosystems.

The concepts of limits and thresholds have been misused in single-species fishery management in the sense that they have been viewed as targets for fish catches rather than levels to be avoided. Because single-species management has prevailed, limits and thresholds rarely have been applied in a broader ecosystem context. Limits in fisheries management often have been biological reference points such as prescribed fishing mortality rates or yields, that are set without concern for other components in the ecosystem. Many limits are in fact thresholds that, when exceeded, challenge the resilience of the managed stock and associated species. Experience has shown that some past target levels used by managers, for example maximum sustainable yield, because they are too close to critical thresholds (Caddy and Mahon 1995), ultimately lead to stock declines or damage to ecological communities. Thresholds are to be avoided to maintain resilience at the species and community levels. Fishery targets should be set conservatively, well below the limits and critical thresholds that compromise the productive potential and stability of the ecosystem. Limits and thresholds of non-targeted organisms have only recently been considered through mandates of the Marine Mammal Protection Act, the Endangered Species Act, and in the new overfishing level definitions, bycatch and essential fish habitat (EFH) provisions of the MSFCMA. Human systems (fishermen, their communities and fishery management systems) are both resilient and generally resistant to change. Thresholds of profitability, tolerance of regulatory conditions, and risk or uncertainty-induced stress on fishery-dependent human communities are real. Thresholds must be determined through both constituent advice and independent research on individual and group responses to stress. Identification of reference points for the limits of human resilience may be possible.

3. Once thresholds and limits have been exceeded, changes can be irreversible. When an ecosystem is radically altered, it may never return to its original condition, even after the stress is removed. This phenomenon is common in many complex, adaptive systems.

It is probable that some estuaries, coral reefs (Hughes 1994), and mangrove ecosystems have been irreversibly altered by fishing, aquaculture, and other habitat-destructive activities. Farther offshore, effects of fishing itself on abundances of target and non-target organisms may radically alter communities and ecosystems. It is too soon to know whether heavily fished systems, such as Georges Bank, will return to their previous states when fishing effort is relaxed (Fogarty and Murawski 1998). Fisheries scientists and managers have demonstrated an abiding faith in the ability of fish stocks to compensate for fishing effects by increasing their level of productivity. Implicitly, that faith is extended to ecosystems which support exploited stocks. Up to a point, recoveries are possible. In some coastal ecosystems, however,

resilience and limits have been exceeded, often by the combined effects of habitat destruction and fishing, and it is doubtful if they will return to their original condition. Changes in ecosystems may permanently alter human behaviours. When a fisherman goes out of business, when an annual season of fishing is disturbed, or when market flow is interrupted, it is often not possible to re-establish the former business, pattern or market. Some aspects of human systems and behaviour can be re-established given enough time and attention, whereas changes in natural components of ecosystems are typically more enduring. In contrast, policy and management systems are continually subject to change and reversal.

4. Diversity is important to ecosystem functioning.
The diversity of components at the individual, species, and landscapes scales strongly affects ecosystem behaviour. Although the overall productivity of ecosystems may not change significantly when particular species are added or removed, their stability and resilience may be affected.

Long-term consequences of diversity losses due to overfishing or poor fishing practices in marine systems are largely unknown. It is clear, however, that the economic value of specific components of catch change dramatically as some stocks are overfished, to be replaced in the ecosystem by lower-valued species (Deimling and Liss 1994, Fogarty and Murawski 1998). At the ecosystem level, drastic alterations of diversity certainly have occurred, and biological productivity has been redirected to alternative species, but it is not clear that these ecosystems are less productive or less efficient. However, such ecosystems are often valued less; witness the loss of tourist revenue in areas that have suffered damage to coral reef systems. It is prudent to presume that changes in biodiversity will decrease resiliency of species, communities and ecosystems, especially with perturbations that occur over long time scales (Boehlert 1996).

This principle also applies to the human element. An economy with more than one sector, a community with more than one industry, a fishing family with more than one income from different sources, or an industry large enough to foster technological innovation, are all aspects of the strength in diversity found in human society. Communities which lose such diversity are more susceptible to stress and unexpected sources of change.

5. Multiple scales interact within and among ecosystems.
Ecosystems cannot be understood from the perspective of a single time, space, or complexity scale. At minimum, both the next larger scale and the next lower scale of interest must be considered when effects of perturbations are analysed.

Consequences of perturbations at one scale in marine systems may be magnified at larger and smaller scales (Langton et al. 1995). For example, destruction of a species' spawning habitat—typically a small fraction of its range—may translate into major impacts on species associations and trophic interactions in the broader feeding areas of recruited fish. Likewise, effects of fishing on a broad ecosystem scale may have profound impacts on components of ecosystems far removed in space and time—scientists are investigating the relationship between pollock fishing and the general decline of Steller sea lion populations in the eastern Bering Sea and Gulf of Alaska. Seemingly small human perturbations, applied at a point in time or in one part of a marine ecosystem, may have unforeseen impacts because of the open nature and fluid environment that characterize marine ecosystems. These features elevate the probability that a stress applied at one scale will be transmitted and may have unforeseen effects at other scales in the ecosystem. Human impacts on ecosystems cannot be understood from the perspective of a single time, space, or complexity scale. A fishing community is subject to perturbations both from its own members and from outside forces. Fishery systems

in one location are subject to environmental, social, economic and regulatory forces far removed in time and space, especially with respect to markets.

6. Components of ecosystems are linked. The components within ecosystems are linked by flows of material, energy, and information in complex patterns.

Critical linkages in marine ecosystems are sustained by key predator-prey relationships. Large, long-lived predators and small, short-lived prey (e.g., forage fishes) both contribute in major ways to marine fish catches. Heavy fishing may precipitate species replacements, both at lower trophic levels (e.g., sand lance replacing herring and vice-versa) and at upper trophic levels (e.g., sharks and rays replacing Atlantic cod) (Fogarty and Murawski 1998). Loss from ecosystems of large and long-lived predators is of particular concern because they potentially exercise top-down control of processes at lower trophic levels. Global data sets have indicated that the mean trophic level of fish caught declined significantly from 1950-1994 (Pauly et al. 1998). Fishing down food webs (i.e., fishing at lower trophic levels) disrupts natural predator-prey relationships and may lead first to increasing catches, but then to stagnating or declining yields. Disruption of ecosystem linkages clearly may have resounding impacts on human economies and, in the worst cases, ecosystem stability and productivity are compromised. Components of human systems are linked by flows of material, energy and information. The collapse of a market may drastically change fishing behaviour. A technological innovation or entry of a new segment of a fishing fleet may cause far-reaching changes in dependent human communities.

7. Ecosystem boundaries are open. Ecosystems are far from equilibrium and cannot be adequately understood without knowledge of their boundary conditions, energy flows, and internal cycling of nutrients and other materials. Environmental variability can alter spatial boundaries and energy inputs to ecosystems.

Productive potential of marine ecosystems is especially sensitive to environmental variability over a spectrum of temporal and spatial scales. The unbounded structure of marine communities provides the backdrop for the high (relative to terrestrial) variability that is observed (Steele 1991). Boundaries of ecosystems, or productive regions, shift with weather and longer-term climate change. Species abundances and distributions vary in accord with annual to decadal shifts in ocean features (e.g., Pearcy and Schoener 1987, Polovina et al. 1995, Roemmich and McGowan 1995, Francis et al. 1998, McGowan et al. 1998). In open systems, local heavy fishing in combination with major changes in ocean conditions (e.g., El Niño), can lead to fishery collapses and associated shifts in the partitioning of energy or biomass among trophic levels (e.g., Walsh 1981, Barber and Chavez 1983).

Human behavioural systems are also subject to variability over a spectrum of temporal and spatial scales, and cannot be understood without knowledge of their boundary conditions. Certain components of human systems (people) are closely related and interact regularly over time; others are only sporadically in contact and interact in cyclical or irregular patterns. The more intermittent or sporadic the contact or interaction, the less stable the human system (Axelrod 1984).

8. Ecosystems change with time. Ecosystems change with time in response to natural and anthropogenic influences. Different components of ecosystems change at different rates and can influence the overall structure of the ecosystem itself and affect the services provided to society in the form of fish catch, income and employment.

Marine ecosystems experience directional changes. Shifts in climate are responsible for many such changes, but the role of biological interactions in the absence of human influence are largely unknown. Dramatic changes in coastal and estuarine ecosystems, attributable to long-term geological and erosion processes are easily observed (e.g., Chesapeake Bay, see Mountford 1996). Anthropogenic changes are all too common, especially in neritic and estuarine ecosystems, or enclosed seas (e.g., San Francisco Bay (Nichols et al. 1986), Great Lakes, Black Sea, Aral Sea, Chesapeake Bay). Species introductions, excess nutrient loading, damming of tributaries, poor stewardship of bordering forests, bad agricultural practices, and poorly-managed fisheries are examples of factors that cause change. Rapid advances in fishing technologies (e.g., vessel power, navigation, sensing-locating and harvest efficiency), the propensity for fisheries to selectively remove species, failure to control bycatch, and unintended damage to the physical structure of ecosystems, have changed the character of heavily fished ecosystems (e.g., Georges Bank) (Fogarty and Murawski 1998). Selective fishing, that often targets long-lived predators, can have cascading effects on community structure (Marten 1979, Laws 1977), while heavy industrial fishing on forage species may have unintended impacts on top predators, especially those (e.g., marine mammals) unable to adapt quickly to changes in the forage base. Removal of large whales through past whaling practices, likewise, may have lingering effects on the nature of ecosystem structures today (National Research Council 1996). Deterioration of coastal ecosystems may also generate active attempts at remediation or enhancement through aquaculture and other means (Morikawa 1994), which can also generate pollution and wastes (Wu 1995).

Human activities dependent on ecosystems may change in response to environmental change and changes induced by fishing and other activities. In the short run, these impacts may be considered the normal consequences of a highly variable activity. However, humans adapt to long-term changes in composition of fisheries by stopping fishing or shifting effort to other species; changes which may produce adverse impacts. In addition, changes in perception, values, preferences, patterns of use, and accumulation of knowledge or expertise may cause changes over time in the ways humans interact within ecosystems. Human components of ecosystems (especially technology and institutions) can change rapidly in ways that outstrip the capacity for change of other ecosystem components. Communities may continue to grow and consumption rates increase, for example, yet the capacity of the seas to increase yields of living marine resources is limited. Thus, fishery management policies must be prepared to take into account these factors.

BROADENING SOCIETAL GOALS FOR ECOSYSTEMS

Traditionally, societal goals have emphasized benefits to humans resulting from extractive uses of ecosystem components. For example, fishery management has typically had revenues, employment, recreational fishing opportunities, and/ or maintenance of traditional lifestyles as explicit or implicit goals. From an ecosystem perspective, these goals need to be broadened to include concepts of health and sustainability (Lubchenco et al. 1991, National Research Council 1999). Ecosystem health is the capability of an ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity and functional organization comparable to that of the natural habitat of the region (Sparks 1995). This concept is also referred to as biotic integrity, which is defined as a system's wholeness, including the presence of all appropriate elements and occurrence of all processes at appropriate rates (Angermeier and Karr 1994, Angermeier 1997). While the concept of health applied to marine ecosystems is relatively new and untested, it has become a guiding framework in several areas, including forest ecosystems (Kolb et al. 1994), agroecosystems (Gallopin 1995), desert ecosystems (Whitford 1995) and others (Rapport et al. 1995).

A healthy ecosystem provides certain ecosystem goods and services, such as food, fibre, the capacity for assimilating and recycling wastes, potable water, clean air, etc. (International Society for Ecosystem Health, 1998). How do we extract from, and otherwise utilize ecosystems, while maintaining their health and the array of non-use services that they also provide (Costanza et al. 1997) into the indefinite future?

The challenge to scientists and managers is to develop useful, quantitative measures of ecosystem health which can guide management. What level of fishing, for example, can a "healthy" ecosystem sustain? How can vigour and resilience be expressed quantitatively so that managers can maintain them within healthy limits? These are difficult questions which will not be answered in their entirety in the foreseeable future, but incremental implementation of ecosystem-based fisheries management will begin to identify ecosystem variables (or indicators) that are unacceptable. These could be used to guide management away from unhealthy ecosystem states.

GENERAL ECOSYSTEM-BASED MANAGEMENT POLICIES

Ecosystem Principles to achieve societal Goals must be implemented through ecosystem-based management Policies. There are three overriding aspects of the Principles that are taken into account in the six Policies discussed below. These are the exhaustibility of ecosystems (reflected in Principles 2 and 3), uncertainty about ecosystems (reflected in Principles 1, 2, 4, and 8), and the role of humans within ecosystems (reflected in all of the Principles). The exhaustibility of the ecosystem requires a policy to change the burden of proof (Policy 1). Both the exhaustibility of ecosystems and uncertainty about ecosystems require policies to manage by a precautionary approach (Policy 2) and to "purchase insurance" (Policy 3) against adverse ecosystem impacts. Uncertainty about ecosystems also dictates that there is learning from management experiences (Policy 4). The role of humans within ecosystems requires policies to make incentives for human behaviour consistent with societal goals for ecosystems (Policy 5). Acceptance and effective implementation of the policies and management is served by promoting participation, fairness and equity (Policy 6). Each of the Policies is discussed below.

1. Change the burden of proof. We live in a world where humans are an import ant component of al most all ecosystems. Thus, it is reasonable to assume that human activities will impact ecosystems. The *modus operandi* for fisheries management should change from the traditional mode of restricting fishing activity only after it has demonstrated an unacceptable impact, to a future mode of only allowing fishing activity that can be reasonably expected to operate without unacceptable impacts.

To date, almost any type of fishing activity has been allowed until problems arise and regulations are established to solve them. Decision makers have to be convinced that management restrictions are needed. As W. F. Thompson (1919) wrote ". . . proof that seeks to change the way of commerce and sport must be overwhelming." Several authors have argued that a change is needed in this "burden of proof" (Sissenwine 1987, Mangel et al. 1996, Dayton 1998).

The key elements of the change are: 1) that future fishing activity should be allowed, if and only if it is explicitly provided for by fishing regulations which take into account risk and uncertainty and are promulgated to protect all elements of the ecosystem, and 2) that to a substantial degree the responsibility for providing the information and other support (e.g., the

cost of management) necessary to manage fisheries in a sustainable manner, lies with participants in the fishery.

The first part of the change is analogous to changing the "null" hypothesis from "marine fisheries are inexhaustible" (Huxley 1883), to today's reality that marine fisheries will usually evolve to a state of overfishing unless they are carefully managed (Garcia and Newton 1997). The second element of the change makes clear that the direct beneficiaries from fishing should accept a greater share of the burden (i.e., costs) of fishery management. The standard of proof associated with the change (i.e., how much certainty is needed before a fishing activity is allowed) should be commensurate with the severity of the risk of a mistake. Applying the proper standard of proof is implicitly an element of the precautionary approach (see Policy 2).

In practice, changing the burden of proof will mean that, when the effects of fishing on either the target fish population, associated species, or the ecosystem are poorly known (relative to the severity of the potential outcome), fishery managers should not expand existing fisheries by increasing allowable catch levels or permitting the introduction of new effort and should not promote or develop new fisheries for so-called "under-utilised species."

2. Apply the precautionary approach. The precautionary approach is a key element of the United Nations Agreement for Straddling Stocks and Highly Migratory Species (United Nations 1996) and the Food and Agriculture Organization of the United Nations (FAO) Code of Conduct for Responsible Fisheries (FAO 1995). The U.S. is a signatory of both.

All ecosystems are complex and uncertainty is unavoidable. Within uncertainty, there is always a risk of undesirable consequences on fishery resources (e.g., overfishing) and/or on ecosystems. The precautionary approach was motivated by the widely accepted conclusion of scientists and fishery managers that many of the current problems of fisheries (i.e., a large number of overfished stocks) have been caused by the practice of making risk-prone fishery management decisions (i.e., to err toward overfishing) in the face of uncertainty (Garcia and Newton 1994). One approach to coping with uncertainty, which is widely applied to other human endeavours, is to encourage behaviours (often by enacting regulations) that reduce risk. Thus, the precautionary approach calls for risk averse decisions (i.e., to err toward conservation). FAO (1995) provides guidelines on the application of the precautionary approach.

3. Purchase "insurance" against unforeseen, adverse ecosystem impacts. Even under the precautionary approach, there is a risk of unforeseen, adverse impacts on ecosystems. Insurance can be used to mitigate these impacts if and when they occur.

Insurance is a common method for guarding against the risks of unforeseen, adverse impacts of many human endeavours, and it has been proposed to guard against adverse ecosystem impacts (Costanza and Cornwell 1992). A requirement to purchase insurance provides an incentive to avoid risk-prone behaviour (to reduce the cost of insurance). Thus, this management policy supports the precautionary approach.

Insurance can take many forms in addition to the traditional form of insurance policies or environmental bonds. Marine protected areas, for example, are a form of insurance. Protecting parts of the ecosystem from exploitation can insure future productivity and sustainability (Carr and Reed 1993, Dugan and Davis 1993, Agardy 1994, Bohnsack and Ault 1996,

Roberts 1997, Lauck et al. 1998). Reserves also serve as baseline areas to evaluate natural variation in animal and plant populations that are free from fishing impacts.

Another form of insurance is a system to detect adverse impacts at an early stage so that actions can be taken to prevent further damage and/or to repair damage. This form of insurance is more effective if corrective actions have already been planned and adopted, such that there is minimal delay when a problem is detected.

Environmental bonding, marine protected areas and a system to detect and respond to adverse impacts can serve as both insurance and elements of a precautionary approach.

4. Learn from management experiences. Management actions and policies can be considered as experiments and should be based upon hypotheses about the ecosystem response. This requires close monitoring of results to determine to what extent the hypotheses are supported.

Sustainable management of complex, adaptive ecosystems must itself be adaptive (Holling 1978). Management policies are experiments from which we can learn and improve, rather than absolute "solutions." Adaptive management in an "active" context would demand that hypotheses be put forward for testing and that alternative models be considered. Active, adaptive management often presumes that changes in fishing mortality rates will be imposed purposefully to induce a response in the fished stock or in the ecosystem under investigation (Walters 1986, Hilborn and Walters 1992). This "active" experimental approach to management is scientifically sound, but may have limited applicability in extensive marine ecosystems, at least within the time scales in which managers must act and in which fisheries operate. Walters (1997), while arguing eloquently about potential advantages of active adaptive management, recognizes the many arguments that detract from its adoption. For instance, modelling exercises and experiments required for the implementation of adaptive management have often been seen as excessively expensive or ecologically risky. A less aggressive form of the adaptive approach, however, is more generally acceptable and applicable. In this form, managers learn from actions to the greatest extent possible and respond expeditiously with alternative management actions. The willingness and institutional capability to respond are critical for this form of management to succeed.

5. Make local incentives compatible with global goals.
Changing human behaviour is most easily accomplished by changing the local incentives to be consistent with broader social goals. The lack of consistency between local incentives and global goals is the root cause of many "social traps, " including those in fisheries management (Costanza 1987). Changing incentives is complex and must be accomplished in culturally appropriate ways.

Global goals, such as long-term sustainability of a fish population or ecosystem health, are generally beyond the control of people at a local scale. Their incentive for conservation is diminished if they have no assurance that others will conserve or if they will not share in future benefits from conservation. This phenomenon is illustrated by the well-known "race for the fish" which can lead to overfishing and wasteful overcapitalisation (Graham 1935, Gordon 1954, Sissenwine and Rosenberg 1993).

A key element of making local incentives consistent with global goals is to allocate shares of the fishery such that people at local scales (down to the scale of individuals) have the incentive to use their shares efficiently (i.e., not wasting resources by racing for a share) and to conserve the entire resource to enhance the value of their shares in the future. Shares can

take many forms such as a fraction of the total allowable catch (known as an individual quota), units of fishing effort, or exclusive rights to fish specific areas. Share-based allocation schemes might be broadened to take account of indirect impacts on ecosystems. There are several options for the local scale to which shares are allocated, such as to individuals or to communities. The most effective configuration of a share-based allocation scheme depends on the specific fishery and ecosystem that is being managed, but some form of share-based allocation will usually be necessary to fulfil this management policy.

6. Promote participation, fairness and equity in policy and management. Ecosystem approaches to management rely on the participation, understanding and support of multiple constituencies. Policies that are developed and implemented with the full participation and consideration of all stakeholders, including the interests of future generations, are more likely to be fair and equitable, and to be perceived as such.

The level and quality of stakeholder participation in fishery management varies widely, as does the definition of "stakeholder." Participation varies from passive consultation to shared decision making authority (Sen and Nielsen 1996). Systems organized to promote the maximum involvement of stakeholders, including the interests of future generations, and to emphasize the maximum appropriate delegation of responsibility and authority to the lowest possible levels of the management system (e.g., the local or regional level), tend to have the highest credibility among fishery constituents (Pinkerton 1989). This often leads to such effects as better data sharing and lower enforcement costs.