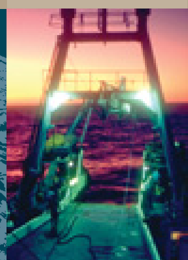
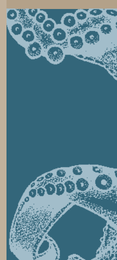
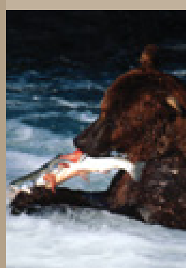
Policy Proposals and Operational Guidance

for Ecosystem-Based Management of Marine Capture Fisheries







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National Library of Australia Calaloguing-in-Publication Entry

Policy Proposals and Operational Guidance for
Eosystem-Based Management of Marine Capture Fisheries
Bibliography.
Includes index.
ISBN 1 875941 25 8
1.Ecosystem management. 2. Fishery management.
3. Fisheries - Environmental aspects. I.Ward, Trevor J. II.
World Wide Fund for Nature Australia.

333.956

Published by: World Wide Fund For Nature Australia

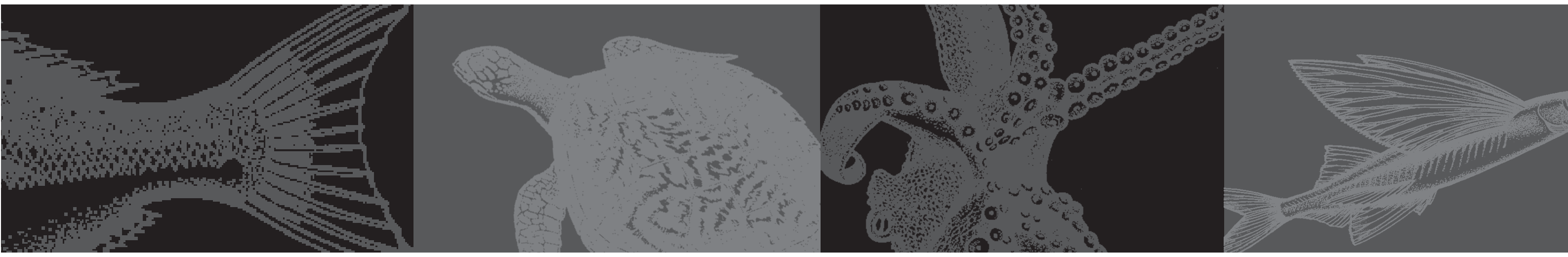
Illustrations by: Bruce Mahalski

Photography: thanks to Michèle Dépraz, Sylvia Earle, Jürgen Freund, Meg Gawler, Karen Gowlett-Holmes, Catherine Holloway, Hartmut Jungius, John E. Newby, Anthony B. Rath, Mauri Rautkari, Kevin Schafer, Albrecht G. Schaefer, Erkki Siirilä, Susan Wells, UNEP/TOPHAM, Yves-Jacques Rey-Millet, Fritz Pölking, CSIRO Marine Research, Austral Fisheries, Baird Publications, Duncan Leadbitter, Katherine Short, Southern Fisherman's Association.

Preparation and publication of this document made possible with funding support from the David and Lucile Packard Foundation.

Editing: Veronica Thorp
Indexing: Clodagh Jones

A six page summary of this document in English, French and Spanish is available from WWF; the summary and this full report can also be downloaded from the websites mentioned below.



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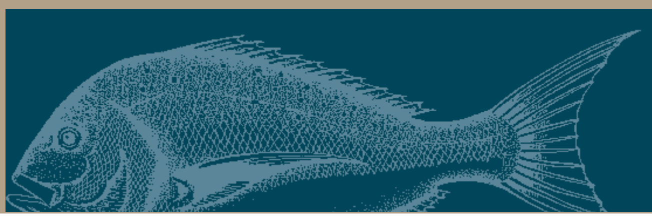
JUNE 2002



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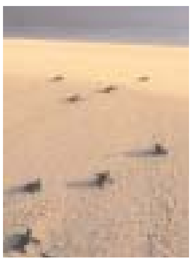
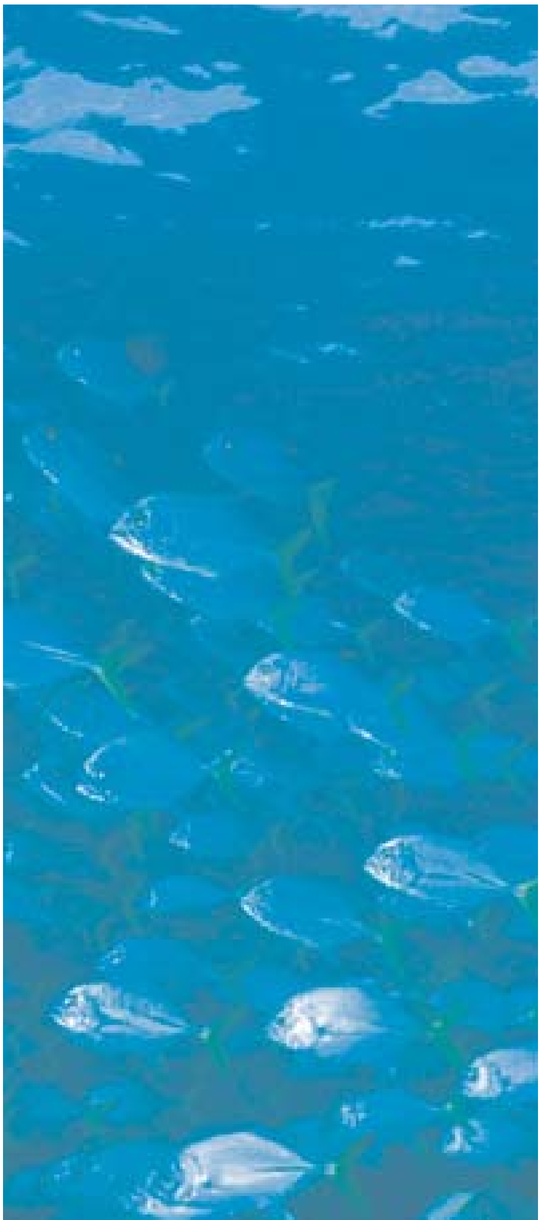


CONTENTS

PREFACE

This paper describes in detail the concept of Ecosystem-Based Management in marine capture fisheries. It is designed to identify the main issues and propose policies and implementation guidance to help resolve those issues. The following map of the section contents may help readers to quickly identify areas that refer to specific matters of interest.



Section 1 discusses the need for improved management of marine capture fisheries, and sets the broad context within which Ecosystem-Based Management (EBM) of fisheries must be implemented.

Section 2 draws together experience from management in a range of sectors to identify the common elements of EBM that apply to the oceans and to fisheries. The basic principles of EBM are summarised, together with aspects of management that are essential for its success. The concept of EBM is described, along with an analysis of what does *not* constitute EBM, in order to show how EBM can be implemented by building on existing fishery management approaches rather than requiring a new management regime.

There are many existing activities that contribute towards achieving EBM goals, and individual elements can be found in various agreements, initiatives, and conservation tools, and are used in various contexts such as business and industry relationships.

Section 3 identifies some examples of these current activities and comments on their suitability for the purposes of EBM. Some of these activities contribute only marginally towards EBM, some have counterproductive aspects, and others have potential that is yet to be proven.

Interpreting the principles and policies of EBM into practical action in a fishery is the most crucial stumbling block.

Section 4 provides an example of how EBM can be implemented by describing what needs to be done, by whom and to achieve what outcome, for a typical coastal fishery.

Section 5 briefly discusses the need for international action to assist with the implementation of the EBM in multi-national fisheries and to more effectively implement the terms of the international conventions and agreements relating to fisheries on the high seas.

Recognising the extent of existing initiatives and instruments, **Section 6** outlines a series of nine delivery mechanisms and ten related enabling activities designed to address the most crucial obstacles that are preventing the broad acceptance and introduction of EBM into fisheries management. These activities are expressed as a set of policy proposals for WWF and collaborating partners to implement.

Section 7: References
Section 8: List of tables
Section 9: List of boxes
Section 10: Glossary of terms used throughout the paper

This paper contains a broad range of ideas, concepts, data and opinions so that EBM can be developed and implemented in marine fisheries. WWF supports and advocates the use of EBM for fisheries, but no statements in this publication shall be regarded as formal WWF policy. The WWF policy on Ecosystem-Based Management and related international and national policy statements are available on request from WWF.

FOREW0RD

The ideas expressed within this paper build on the initiatives and events of the 1990s, including the development of the FAO Code of Conduct for Responsible Fisheries and the 1998 WWF/IUCN International Marine Policy, Creating a Sea Change. WWF seeks to maintain the momentum for marine conservation highlighted in 1998, the International Year of the Ocean. Additionally, it is useful and timely to build on the October 2001 FAO *Reykjavik Conference on Responsible Fisheries in Marine Ecosystems*, strengthening the discourse and providing clear guidance for the effective implementation of the objectives of these initiatives.

WWF is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in more than 90 countries.

WWF's mission is to stop the degradation of our planet 's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resources is sustainable
- promoting the reduction of pollution and wasteful consumption.

WWF

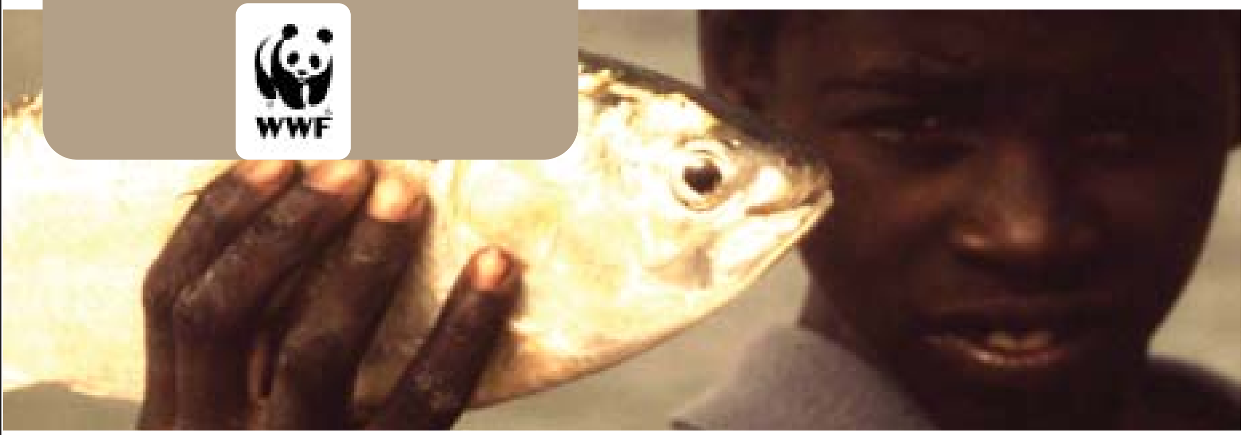
WWF believes Ecosystem-Based Management provides a framework for humanity to secure ongoing production of food resources from healthy marine ecosystems while enabling these ecosystems to continue to function and evolve.

While the paper provides a conceptual framework for the development of global policy and best practice for effective ecosystem management, it is by no means exhaustive. Indeed, the very essence of an effective Ecosystem-Based Management framework dictates that it is adaptive and open to new concepts and approaches to implementation.

WWF acknowledges that in some countries, more cautious decisions are being made, cultures are changing, partnerships are developing and evolving and, in places, humanity's interactions with marine ecosystems are being managed more sustainably.
Yet considerable investment, action and coordination are urgently needed to change behaviour in the immediate future, in the coming months and years, rather than decades. WWF welcomes new partnerships to help implement Ecosystem-Based Management of marine capture fisheries and the last section of this paper outlines an action plan to achieve this.

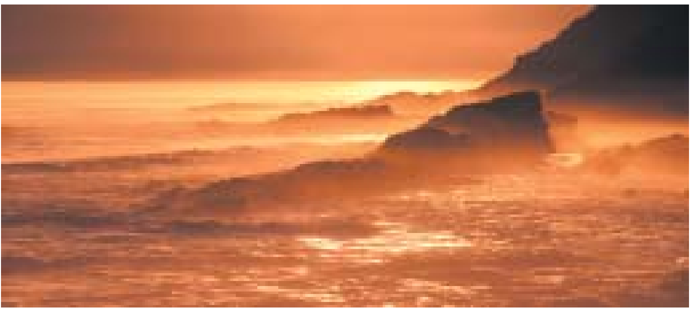
WWF greatly appreciates the technical and policy advisers who brought the ideas in this policy paper into a coherent form, Diane Tarte and Eddie Hegerl of Marine Ecosystem Policy Advisors Pty Ltd, Brisbane, Australia, and Dr Trevor Ward of the University of Western Australia. Excellent contributions have also been provided by WWF network officers around the world and by invited technical contributors. The draft versions have been improved by the excellent peer reviews from Dr Stephen Hall, Director of the Australian Institute of Marine Sciences and Dr Andrew Rosenberg, Dean, College of Life Sciences & Agriculture, University of New Hampshire. Lastly, we thank the David and Lucile Packard Foundation for providing the funding support to prepare this document.

Dr Claude Martin,
Director General, WWF International
Gland, June 2002



EXECUTIVE SUMMARY

The world's oceans and coastal fisheries have been degraded and are continuing to decline. While there have been many agreements, conventions, programs and initiatives in the past five decades that have recognised these problems and proposed action, there has been only limited success in preventing the ongoing problems of overfishing, degradation and loss of habitat, and loss of marine biodiversity. The world's fish catch is now acknowledged to be in decline, and very urgent action is required.



The issues seem clear enough, that fishing effort is too high, coastal development continues to destroy crucial fisheries habitats, nutrient runoff continues to pollute bays and estuaries, and more, but the solutions to such problems are highly complex. In many cases they will require good planning and community involvement to minimise or eliminate adverse short-term economic and social impacts in preparing the way for more sustainable human communities and ecosystems in the future.

In fisheries, Ecosystem-Based Management (EBM) has been identified as a management approach that is likely to succeed where many other initiatives have failed. However, the concept of Ecosystem-Based Management for marine capture fisheries is still unclear, there is no agreed standard approach, and further, fisheries have yet to fully embrace the principles. There are many effective sustainability initiatives operating in different individual fisheries around the world, but they remain to be integrated into a fully effective EBM approach.

WWF has prepared these Policy Proposals and Guidelines to encourage and inform the global debate and provide an operational interpretation of how to apply the principles of Ecosystem-Based Management to marine capture fisheries. The Paper is designed to build on existing knowledge and approaches to develop the concept into a workable approach for implementation in individual fisheries, consistent with integrating global and regional policy requirements into national arrangements for on-ground and 'in-water' actions.

The Principles of Ecosystem-Based Management are:

1. **Maintaining the natural structure and function of ecosystems, including the biodiversity and productivity of natural systems and identified important species, is the focus for management.**
2. **Human use and values of ecosystems are central to establishing objectives for use and management of natural resources.**
3. **Ecosystems are dynamic; their attributes and boundaries are constantly changing and consequently, interactions with human uses also are dynamic.**
4. **Natural resources are best managed within a management system that is based on a shared vision and a set of objectives developed amongst stakeholders.**
5. **Successful management is adaptive and based on scientific knowledge, continual learning and embedded monitoring processes.**

A successful Ecosystem-Based Management system will:

1. **Operate within a supportive *policy framework*.**
2. **Recognise *economic, social and cultural interests* as factors that may affect resource management.**
3. **Recognise *ecological values* and incorporate them into management.**
4. **Provide adequate information on *utilised species* to ensure that overfishing is a low risk.**

5. **ensure that the *resource management system* is comprehensive and inclusive, based on reliable data and knowledge and uses an adaptive approach.**
6. **environmental *externalities* are properly considered within the resource management system.**

In a typical fishery, the ecological aspects of EBM would be implemented using the following steps:

1. **Identify the stakeholders: the interested parties.**
2. **Prepare a map of the ecoregions: species, habitats and oceanographic features.**
3. **Identify the partners and their interests: stakeholders directly interested or affected by the fishery.**
4. **Establish the ecosystem values: habitats, species and uses.**
5. **Determine the main potential hazards of the fishery to the ecosystem values.**
6. **Conduct an ecological risk assessment: determine the actual risks of the fishery.**
7. **Establish the objectives and targets: agreed goals for the ecosystem and the fish stock.**
8. **Establish strategies for achieving targets.**
9. **Design the information system: includes monitoring of stock and ecological indicators.**
10. **Establish information needs and research priorities.**
11. **Design performance assessment and review process.**
12. **Design and implement an EBM training and education package for fishers and managers.**

There are many existing initiatives that operate to improve the way in which ecosystems are considered within fisheries management systems. However, they are typically uncoordinated and do not necessarily work in harmony with other initiatives designed, for example, to improve the management of fish stocks. Some of these initiatives are described, including those making good progress and others where progress is slow or weak.

To overcome the main obstacles to the adoption and implementation of EBM, while recognising the existing initiatives and activities, nine key gaps and a corresponding set of ten high priority corrective and enabling activities are identified:

1. **Improve *education and awareness* about Ecosystem-Based Management of marine capture fisheries and its potential benefits.**
2. **Document and promote good models for *stakeholder engagement* in management planning.**
3. **Develop and promote robust procedures for determining ecosystem management *objectives, indicators and targets.***
4. **Conduct *assessments of existing management systems* in major global fisheries.**
5. **Fishers and stakeholders to collaborate in a pilot program to implement *fully-protected reserves* within fisheries, to provide areas for conservation of biodiversity.**
6. **Foster *integrated regional planning, management and assessment* activities.**
7. **Foster the design and implementation of a *global fund to restructure fisheries* to reduce effort in a manner that increases sustainability.**
8. **In partnership with other stakeholders undertake specific case studies to design and *implement* Ecosystem-Based Management as *demonstration projects in selected fisheries.***
9. **Involve other sectors in Ecosystem-Based Management of the marine environment.**

In seeking to ensure the sustainability of global fisheries and the continued well-being of both human communities and marine biodiversity, WWF commends this Paper to all those with a vital concern for the oceans. We seek to join with partners to implement these high priority activities bringing a new focus on ecosystems for the future health of the world's oceans.

1

INTRODUCTION

This paper has been prepared to describe Ecosystem-Based Management (EBM) for marine capture fisheries, to explain the principles of an effective EBM approach, to outline some examples of aspects of EBM for fisheries management being implemented successfully, and to set an agenda for developing an EBM framework for the world's oceans. The paper sets the context; it describes the concept and principles of EBM, and what EBM is not. It describes examples of work already underway to develop and implement EBM around the world specifically in fisheries management and highlights some of the effective components of, and approaches to, current fisheries management systems, as well as some of the necessary changes. However, while it is important to note that the paper identifies many important interactions with other marine sectors, no attempt is made in this paper to set a comprehensive framework for EBM for all sectors using the world's oceans (such as shipping, oil and gas, tourism, mining). The focus here is on fishing and the impacts of fishing as a first step in developing an internationally accepted, ecologically-based framework for the sustainable management of human activities in the world's oceans.

The principles for implementing EBM described in this paper can, and should, be extrapolated and applied to other sectors. In places throughout the WWF network, this work is already underway. This wider use of EBM principles is embodied in the integrated, regional marine planning approach becoming known as 'Oceans Policy', which is gaining momentum in Canada, Australia, New Zealand and the United States.

The key message of this paper is that EBM is not a quick fix, or the solution to all of the problems facing the marine environment and the extraction of resources from it. However, we can better manage our impacts on marine ecosystems. This requires the appropriate control of human activities, which are inextricably linked to ecosystem conditions, to maintain diverse, healthy and productive marine ecosystems.

In fisheries, Ecosystem-Based Management takes account of the consequences of the interactions of fishing with the ecosystem. EBM is best achieved through an inclusive management approach involving stakeholders in setting a collective vision for the marine environment. This vision must address stakeholders' aspirations, as well as recognise the needs and limits of marine ecosystems. In particular, Ecosystem-Based Management acknowledges that human impacts on ecosystems can affect fish stocks and their productivity, and in turn, human uses of ecosystems, including fishing, can adversely affect ecosystems. The sum of these interactions must still permit ocean ecosystems to be maintained in a healthy condition, and this is what EBM strives to achieve.

Ecosystem-Based Management of fisheries makes ecological sustainability the primary goal of management, as well as recognising the critical interdependence between human well-being and ecological health.

'Ecosystem management breaks new ground in resource management by making the social and political basis of natural resource management goals explicit and by encouraging their development through an inclusive and collaborative decision-making process. Ecosystem management is based on an ecosystem science that integrates many disciplinary approaches and addresses the ecological issues at very large temporal and spatial scales. Given the recognised complexity and dynamic nature of ecological and social systems, ecosystem management is adaptive management, constantly being re-assessed and revised as new information becomes available.' (Cortner & Moote 1999).

For practical implementation in fisheries, Ecosystem-Based Management means taking careful account of the condition of ecosystems that may affect fish stocks and their productivity. It also means taking equally careful account of the ways fishing activities may affect marine ecosystems. This means, where necessary, changing the way in which the fishery operates, adjusting the type of gear used, or imposing closed areas to protect biodiversity or habitats critical to the whole fishery or to the biodiversity of the region. And further, it means taking an inclusive approach to setting goals and objectives for harvested fish and the ecosystem the fish comes from, recognising ecosystem interactions, integrating activities across a range of other users and resource sectors, and respecting the broad range of values society has for the marine environment. For this, operators within a fishery must recognise that they are one group amongst many stakeholder groups entrusted to use, manage and conserve Earth's marine ecosystems.

WWF's mission is to stop the degradation of the planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity.
- ensuring that the use of renewable resources is sustainable.
- promoting the reduction of pollution and wasteful consumption.

To achieve its mission WWF's approach is always to recognise the needs of humanity but stress that these needs must be met within the finite limits of natural systems, that is, the fundamental limits of the natural carrying capacity of ecosystems. Once a baseline has been established for a given ecosystem (see Box 1), once the ecosystem has been defined and the limits bounded, we can decide how to proceed. It is also important to recognise that we will never possess the full extent of the facts and necessary information when making decisions. A highly precautionary approach will therefore always be needed. Recognising that ecosystems and fish stocks are dynamic, achieving genuine sustainability will require substantial buffers to allow for uncertainties in our understanding and permit ecosystems and fish stocks to adapt and respond to changes.

In the marine environment, WWF's approach to Ecosystem-Based Management is to foster area-based management across the oceans. This would result in selected intensively managed and defined production environments and comprehensive, adequate and representative networks of highly protected areas contributing to the conservation and management of biodiversity and health of the surrounding ecosystem. The variability and uncertainty in species distributions, currents and other oceanographic features makes definition of ecosystem boundaries complex. However, WWF believes that stakeholders must explicitly state their management objectives for production (including harvesting of fish), for biodiversity conservation and for other values and incorporate these into an ecosystem-based spatial management framework.

The need to consider spatial management, information sufficiency and stakeholder interests requires a highly integrated approach to management. Ecosystem-Based Management must therefore be operationally expressed in ways that admit all the complexities of ecosystem dynamics, social and economic needs of dependant human communities, and the maintenance of diverse, functioning and healthy ecosystems.

Marine ecosystems often traverse human-derived borders, so realising and implementing this vision for EBM will require a cooperative effort amongst the nations and peoples of the world. At times competing needs, competing values and cultural differences will have to be reconciled through the robust use of the principles of EBM described in this paper.

Ecosystem-Based Management is a tool for fishery and other marine managers to manage fish stocks within the boundaries necessary to maintain ecosystem integrity. WWF believes these principles can take humanity a substantial way forward toward achieving both the sustainable use of marine resources and the preservation of marine biodiversity.

BOX 1

MANAGING UNDER SHIFTING BASELINES AND GHOSTLY ECOSYSTEMS

Marine ecosystems are poorly understood in that we know little about how they work, how ecosystem functions are linked to fishery productivity, and about many of the species beyond the shoreline. This lack of knowledge prevents accurate predictions about what marine ecosystems could look like in the absence of fishing or other human impacts (such as eutrophication, sedimentation, and coastal development).

The evidence about what relatively natural ecosystems should look like is derived from studies of minimally disrupted ecosystems in remote places, from the limited historical evidence gleaned from paleo-ecological records, and from social history where communities with strong maritime associations remain intact. Consequently, judgments about the quality of today's ecosystems are strongly influenced by comparing the different ecosystem types existing today and not by comparison with 'how things once were'.

In ecological studies, benchmarks for ecosystem condition can only be derived from recent knowledge. Since there are few long-term datasets with sufficiently quantitative detail, ecologists are forced to build models for predicting ecosystem conditions. When such models are based on the structure and function observable in today's ecosystems, most of which are considered to be highly affected by fishing, they are unlikely to be very accurate. When checked against paleo-ecological data, predictions based on contemporary knowledge seem 'unbelievable'. The historical abundances of large species of fish are considered 'fantastically large' in comparison to the abundances in present-day fish populations (Jackson et al. 2001).

Clearly today's marine ecosystems have never looked like this before. We are presiding over an incremental set of changes to marine ecosystems that are happening on time and space scales that are hard for us to conceptualise. Because they are generally concealed beneath the surface of the oceans, and directly observed by only a few, most of the changes have passed unnoticed. Fishing appears to have long preceded our earliest attempts to document the nature and condition of marine, especially coastal, ecosystems (Dayton et al. 1998). Fishing may also have preceded all other major human impacts in marine ecosystems, and it is plausible that the impacts of fishing may have reduced the resilience of marine ecosystems to other human impacts (such as eutrophication) and pre-conditioned ecosystems for subsequent change (Jackson et al. 2001).

It is also clear that preventing any further decline in marine ecosystems is imperative. Setting targets and benchmarks for ecosystems are highly influenced by 'shifting baselines', where successive generations of marine managers slightly lower their expectations for what is an acceptable condition for the high quality function and structure of ecosystems.

Adopting targets for ecosystems that recognise the evidence from paleo-ecology about the diversity and size range of animals and plants in ecosystems before the broadscale spread of fishing is probably the only cautious and prudent approach for setting future targets for ecosystems. Other ways of estimating pre-fishing conditions in ecosystems use measurements and models derived from fully protected marine reserves that successfully exclude all fishing as well as other extractive uses, (see Key Action #5) and from traditional ecological and historical knowledge from local communities. Progress towards these targets will probably depend on correcting the impacts of fishing before improved practices in other sectors can take effect, except in circumstances where there are gross environmental impacts, such as the discharge of industrial wastes.

It is unrealistic to expect that pre-fishing targets for ecosystems could ever be fully reached given: the irreversibility of many changes to coastal ecosystems; the dynamic nature of marine ecosystems; and the impracticality and inequity of making sudden shifts that affect present-day fishing communities. However prompt action and equitable intervention is crucial to reverse this incremental, slow, and seemingly inevitable, march towards the ghost of past ecosystems.

2 ECOSYSTEM-BASED MANAGEMENT: THE CONCEPT

The concept of 'Ecosystem-Based Management' (EBM), which is abbreviated to 'Ecosystem Management' in some countries, has evolved over the past few decades in response to two properties of managed natural systems:

1. **Exploited natural resources are highly connected to their surrounding ecosystems, although not necessarily directly and immediately, and this connectivity can have major effects on their productivity;**
2. **The exploitation of natural resources can have effects on other resources and on other (non-utilised) species and aspects of the ecosystems where the resources occur, and these direct and indirect effects can have very major consequences for related or dependent species.**

These two main properties can be summarised as (1) the effect of the environment on the resource being exploited, and (2) the effect of resource exploitation on the environment. Both are of central importance and modern management systems attempt to address both types of environment and ecosystem interactions.

As we have discovered that the world's natural resources are finite, and the global fish catch is declining despite increased fishing effort (Watson & Pauly 2001), we have begun to acknowledge that resources should not be over-exploited, nor exploited without detailed consideration of the interaction with the ecosystems from which they derive. Thus, the theoretical constructs behind EBM have been conceptualised into working definitions to guide management in many situations. However, the need for a solid scientific basis for operationalising the concept of EBM and the diversity of sectoral interests and scientific issues have led scientists to a wide variety of approaches to EBM (Christensen et al. 1996).

Some approaches to EBM advocate a strictly ecological focus to maintain the capacity of an ecosystem to deliver desired goods and services. But other approaches more appropriately extend the EBM concept to include human goals and aspirations for ecosystems. These latter approaches recognise the highly managed nature of all terrestrial production systems and their associated ecosystems, and that the notion of 'sustainability' is a human construct driven by the socio-economic and cultural context within which resource management must reside (Pirot et al. 2000). It is this approach that needs to be applied to our use of marine environments and associated ecosystems, and to fisheries management (FAO 2001).

2.1 The Principles of Ecosystem-Based Management

Despite the diversity of views and experience with EBM in various jurisdictions, reasonable consensus is emerging across a broad range of different resource sectors (forestry, civil society, marine) about the nature of the basic principles that underpin and empower implementation of EBM. (See Pirot et al. 2000, Ecosystem Principles Advisory Panel 1998, Ward et al. 1997, Harwell et al. 1996, and Box 2).

These principles can be summarised as:

1. Maintaining the natural structure and function of ecosystems, including the biodiversity and productivity of natural systems and identified important species, is the focus of management.
2. Human use and values of ecosystems are central to establishing objectives for use and management of natural resources.
3. Ecosystems are dynamic; their attributes and boundaries are constantly changing and consequently interactions with human uses also are dynamic.
4. Natural resources are best managed within a management system based on a shared vision and set of objectives developed amongst stakeholders.
5. Successful management is adaptive and based on scientific knowledge, continual learning and embedded monitoring processes.

BOX 2

REGIONAL AGREEMENTS – Lessons from the North East Atlantic

Marine policy in the North East Atlantic has developed rapidly in the last decade, greatly influenced and enhanced by frameworks and law under the auspices of the United Nations (UN)[1] that support the long-term protection of the marine environment for future human generations. They refer to management approaches that need to be precautionary and are developed and implemented from an ecosystem perspective. They identify the importance of including all legitimate interests in management decisions.

There are also other significant and important principles[2] to consider. The challenge now is to make these policies and management concepts successful operationally. This requires full agreement on solutions from all legitimate interests, or a process by which decisions can be made if there is disagreement and/or uncertainty.

In the North East Atlantic and surrounding regional seas, there are a number of initiatives that either need to meet the requirements of international agreements, or that are considering, developing and implementing strategies to move forward[3].

Largely because of the traditionally sectoral approach to marine management there is still poor integration between policy and management of sectors including fisheries, oil and gas, mineral extraction, land and sea-based pollution, and shipping. It is important to recognise that the conservation of biodiversity is an overarching goal that should be integrated into the management of all activities. Regional seas conventions such as the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR) are addressing the integration of some activities but have no competence over fishing. There is no recognition of the OSPAR strategies in fisheries policy and management, for example, in the Common Fisheries Policy (CFP) or the North East Atlantic Fisheries Commission (NEAFC). There is also the added complication that some sectors are presided over or influenced by a competent global authority, such as the International Maritime Organisation (IMO) that manages shipping internationally.

There has been substantial progress in recognising the key issues that need to be resolved to implement Ecosystem-Based Management in the five OSPAR regions[4]. They are examples of specific priority actions that are needed to implement EBM globally.

WWF is advocating the adoption of an integrated and multi-disciplinary ecosystem-based approach to the management of human activities in the OSPAR Maritime Area.

Priority issues that need to be progressed for all OSPAR regions include:

- The need for protection of species and habitats (as assessed by the Biodiversity Committee) to be reflected in fisheries management. This requires links with fisheries management structures such as the EU Common Fisheries Policy, the North East Atlantic Fisheries Commission, the International Convention on the Conservation of Atlantic Tuna and the North Atlantic Salmon Conservation Organisation.
- An operational strategy is required to integrate the management of fisheries with the management of other human activities on a regional basis.
- Development of a habitat classification and guidelines for the designation and management of a network of representative Marine Protected Areas (MPAs). This work should be linked with existing initiatives such as the EU Habitats and Birds Directives, the national MPA networks and on a global level, potential developments for identifying and managing High Seas MPAs.

[1] For example, the UN Food and Agricultural Organisation (FAO) Code of Conduct for Responsible Fisheries (1995), UN Agreement on Straddling Fish Stocks and Highly Migratory Fish Stocks (1995), UN Conference on Environment and Development (UNCED, 1992) and the Convention on Biological Diversity (CBD, 1993).

[2] For example, The Malawi Principles from the CBD Workshop on the Ecosystem Approach, Malawi 26-28 January 1998 and principles to implement Ecosystem-Based Fishery Management (Ecosystem Principles Advisory Panel, 1998).

[3] These initiatives include the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR),the Helsinki Convention (HELCOM), the Barcelona Convention (BARCOM), the European Union's Common Fisheries Policy Review, European Union's Habitats Directive, the North East Atlantic Fisheries Commission (NEAFC), the International Baltic Sea Fisheries Commission (IBSFC), the North Sea Conferences and the Committee of North Seas Senior Officials (CONSSO), the Irish Sea Cod Recovery Plan, which is implemented by the European Union, and the North Sea Commission Fisheries Partnership.

[4] The OSPAR Maritime Area is divided into five subregions, namely the Arctic Water, Greater North Sea, Celtic Seas, Bay of Biscay and Iberian Coast, and Wider Atlantic.

BOX 2 cont

WWF is calling on Contracting Parties to OSPAR to start developing practical delivery mechanisms and management actions to implement a fully integrated ecosystem approach in its regions and ecologically meaningful sub-units. These actions include:

1. Develop an institutional framework for regional co-operation, including representatives of all legitimate interests in the region, to negotiate and decide upon strategies for practical management measures, implementation and enforcement.
2. Integrate the ecosystem approach across sectoral and inter-sectoral policies, plans and programs, including National Biodiversity Strategies and Action Plans and National Strategies for Sustainable Development.
3. Facilitate inter-agency co-ordination and support on a regional basis to provide sufficient information and appropriate technology to enable management measures to be implemented in a timely fashion and adequately enforced.
4. Target research and technical development to improve the management of marine resources especially in fields where there are linkages between science, technology, social welfare and economics.
5. Integrate all available data for mapping all human activities and conservation values (from the regional Quality Status Reports).
6. Design a network of MPAs for the conservation and fostering of marine fauna and flora.
7. Define the policy goals and design spatial planning of spatially fixed human activities (e.g. oil and gas installations, windmills) in relation to marine conservation objectives.
8. Design and evaluate biological monitoring programs tailored to measure possible effects of implemented management measures.

Prepared with contributions from: Simon Cripps (WWF International), Sarah Jones (WWF UK), and Stephan Lutter (WWF NE Atlantic Program).

2.2 Experience So Far

Experience gained in a range of biomes and types of resource management has provided a number of salutary lessons for the operational implementation of EBM (Pirot et al. 2000). The three basic operational elements of EBM necessary for success are:

1. *Develop outcome-oriented objectives* for management activities – clearly express what the resource management system is attempting to achieve.
2. *Delineate boundaries for the management system*, including ecologically-defined spatial boundaries, and all relevant ecological and socio-economic factors influencing the productivity of the resource and the integrity of its ecosystem.
3. *Involve stakeholders* in all aspects of the management system leading to shared and agreed individual and collective aspirations for the resource and associated ecosystems.

All case studies and projects designed to demonstrate EBM have stressed the importance of recognising and including human uses in planning and implementing EBM. This includes striving to achieve a shared vision, goals and outcomes for ecological systems and resource uses (for example Harwell et al. 1996). To improve the sustainability of US fisheries the National Marine Fisheries Service (NMFS) has applied a set of guiding principles, goals and policies to derive a 'pragmatic framework' for implementing EBM. The NMFS approach is based on scientific analysis; acknowledges externalities that influence the sustainability of fisheries; and recognises the need for engaging human and institutional elements affecting fisheries. It calls for targets for ecosystem health to be developed within the context of the fisheries management system (Ecosystem Principles Advisory Panel 1998).

This experience suggests that the procedures and elements of any EBM system must be flexible, be scientifically robust but not science-controlled, admit socio-economic factors, be based on the full participation of stakeholders, and encompass (or facilitate) a clear connection between the various levels of planning and management (Pirot et al. 2000).

This means, for example, ensuring that there are clear, effective and efficient connections relating global and regional policies and strategies to the operational activities within each resource sector (such as a fishery). These explicit connections in planning and management need to operate within each level, amongst and across the various sectors, including the conservation community. This network of connections enables the integration that is essential for a resource management system to successfully contribute to the achievement of

EBM goals <u>and</u> to robust resource management at local, national, regional and global levels.

A number of countries including Canada, Australia, New Zealand and the USA, are attempting to integrate management of their ocean regimes within the context of the United Nations Convention on the Law of the Sea. Generally termed 'Oceans Policy', these national initiatives seek to achieve the integration of marine management systems and the ecological sustainability of all marine resource uses (see Box 3).

The need for integration in oceans management systems is perhaps best demonstrated by the multiplicity of existing management regimes that have an effect on the oceans, but lack coordination and consistency. Because of this lack of integration, resource sectors, such as fishing, that rely on the maintenance of ocean ecosystems are not able to control many of the factors that degrade those same ecosystems. Similarly, achieving conservation of biodiversity in the face of a multitude of uncoordinated pressures on ecosystems is a highly complex problem.

The more integrated approaches propose to manage the oceans on a regional basis, considering all uses in the context of their impacts on biodiversity. These approaches to resource use and biodiversity conservation entail agreements from all users to reduce activities that may degrade specific areas or values of conservation importance, but permit activities to occur in areas where they do not threaten regional biodiversity objectives.

The regional management approach identifies specific uses that are acceptable in ocean zones, and identifies complementary MPAs to ensure regional biodiversity is maintained. MPAs that offer various levels of protection (from 'no-take' to 'sustainable use') avoid the syndrome of MPAs as 'islands of management in a sea of mismanagement'. Implementing this approach requires a careful evaluation of users' interests and the capacity to identify regional biodiversity objectives that can be used within a planning framework and management system. A successful regional management approach will need to recognise both the legitimate interests of ocean users and the biodiversity imperatives in formulating strategies and management measures for specific uses, resource allocations and preserving biodiversity.

BOX 3

AUSTRALIA'S OCEANS POLICY

Australia's Oceans Policy developed in 1998, introduced an integrated planning and management regime for the country's EEZ, to be implemented through a regional marine planning process. Regional marine plans, based on large marine ecosystems, will integrate commercial interests and conservation requirements by assessing the potential use of marine resources and determining how to allocate them to optimise economic, social and ecological benefits.

Australia's Oceans Policy contains a range of commitments relevant to sustainable fisheries including:

- to pursue Ecosystem-Based Management of the resources of the EEZ, aiming to ensure ecosystem integrity
- to implement a strategic approach to assess whether fisheries are managed sustainably
- to implement the 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 and to increase surveillance activity
- to develop and implement mechanisms of structural adjustment for federally-managed fisheries suffering from overcapacity and excess fishing effort
- to provide support for initiatives that will promote and demonstrate ecologically sustainable uses, multiple management and use of sea resources by indigenous communities
- to continue to address land-based sources of marine pollution
- to continue work on ballast water management
- to assist in the establishment of an introduced marine pests incursion management system
- to ban the use of tributyl tin anti-fouling paints in Australia and pursue a similar ban globally.

Source: Commonwealth of Australia. 1998. Australia's Oceans Policy. Volumes I and II.

2.3 Incorporating Uncertainty into Ecosystem-Based Management of Fisheries

Broadly speaking, we can classify marine ecosystems and habitats based on their structure and some of their functions. However their real nature and how they function are largely unknown, and there appears to be no general theory that can be used to describe all marine ecosystems (Cury et al. 2001). Similarly, although many impacts of fishing have been recognised, the precise ways in which fishing affects ecosystems are poorly understood. Measurements in fisheries and ecosystems are always samples and estimates, with errors and biases in the measurement procedures. Moreover, the characteristics of a particular fishing activity, such as the spatial intensity, usually are not known on a scale fine enough to precisely determine the impacts of fishing on species, habitats and ecosystems. The net result is that even where objectives and targets are set, e.g. to maintain the structure of habitats, the difficulties of precise measurement often preclude determining whether such targets are achieved.

Although many aspects of a fishery management system are uncertain, decisions about fishing activities still have to be made. In determining objectives and setting targets, developing strategies and plans, and determining fine scale aspects of the controls on fishing effort (such as approved gear types, fishing places and times), decisions need to be based on multiple lines of evidence. However, to ensure that these decisions are consistent with achieving EBM and that objectives for the fishery can be attained in relation to conservation of species and habitats, the uncertain impacts of fishing will usually mean a conservative and precautionary approach must be used when taking decisions.

A precautionary approach to decisions means, 'when in doubt, err on the side of conservation' (Sissenwine & Mace 2001). But EBM in fisheries requires more than a series of cautious decisions. A comprehensive precautionary approach to fisheries management relies on three important elements. These are: (1) a policy that has been set to be explicitly precautionary; (2) an assessment process that is precautionary in that it fully considers and incorporates uncertainty, and (3) the burden of proof for demonstrating there are no major unacceptable impacts rests with the fishery. Here the 'goalposts' that establish the acceptability of fishing-induced changes are defined by the policy and are operationally established in the assessment process. Consequently, where fishing effects appear to be generating scientifically or socially-determined unacceptable impacts on ecosystems, habitats, or non-target species, the lack of full knowledge about these impacts must not prevent appropriate measures being taken to mitigate the impacts.

The burden of proof for assessing the impacts of fishing rests with the fishery. This is because of the long history of fishery effects in coastal ecosystems and the magnitude of these impacts. Thus, the lack of an impact of a fishery, or the minor or acceptable nature of an impact of fishing, would be the responsibility of the fishery to determine and demonstrate. This might involve the use of various lines of evidence, including data and knowledge derived from other similar fisheries, information from other marine sectors operating in the same ecosystems, or by comparison with other circumstances in other ecosystems. The relevant lines of evidence within a fishery would be best gathered by designing adaptive management approaches and large-scale experiments that focus on targets for ecosystems, habitats, etc, as well as using monitoring and measurement systems designed to answer specific questions about fishery performance. A successful example of one such approach is Management Strategy Evaluation (see Box 6).

Much of the required monitoring can be undertaken by fishers themselves, which provides an opportunity for fishers to demonstrate that they accept the need for EBM, and are committed to sharing the responsibility for minimising the impacts of their fishing activities.

Including wider stakeholders in the assessment and scrutiny of this information and the justifications for management recommendations and decisions is the final step in an EBM framework. Such a comprehensive, inclusive and participatory approach is now widely recognised as being critical for EBM to be successfully achieved (see for example FAO 2001, Mathew 2001, Sissenwine & Mace 2001).

Although including stakeholders and ecosystem objectives increases the complexity of fishery management systems, without this they are constrained to only one component of the real fishery management problem, i.e. the stock issues. This leads to a false sense of security within fishing management circles, and risks failing to deal effectively with ecosystem issues, the needs of fishing communities and the increasing expectations of the rest of society. Dealing with the full gamut of uncertainties in comprehensive fishery management systems is certainly more difficult than western, science-based, single-species, traditional stock management. However reducing the problem only to components amenable to easy solutions is counter-productive, promoting 'pseudo-power', the situation where a complete, accurate and precise answer is developed to the wrong question (Ward & Jacoby 1995).

For EBM to be effectively implemented, fishery management systems must develop and employ tools and approaches that appropriately recognise the uncertainties associated with both stocks and ecosystems. A number of tools exist (see Butterworth & Punt 2001, Sainsbury & Sumaila 2001), but we need more emphasis on developing the ecosystem aspects into approaches that can be readily operationalised in day-to-day fishery management (See Key Action #9).

The high level of uncertainty about many aspects of fishing, its impacts on ecosystems, and the difficulty that stakeholders face in conceptualising and expressing their concerns and expectations in a way that is useable within the fishery management system creates difficulties for stakeholders and managers. They often will need to resort to a default set of objectives and targets that are derived from an external policy or set by an external framework. Conceptualising and expressing such external constraints can provide important EBM guidance within the fishery management system. It can provide for interim objectives and targets to be established that meet both stakeholder expectations and broader policy expressions.

Where a fishery does not have its own well-developed objectives and targets (the common situation in respect of ecosystems), stakeholders will need to resort to external policies and practices as a guide for what the EBM of the fishery should be achieving. Without this, a fishery management system may be able to avoid dealing effectively with issues of concern to stakeholders by sheltering behind the lack of timely data and information, playing for time, and even (in resistant fisheries) developing strategies to avoid implementing the principles of EBM.

External policy guidance and inputs may be broad and conceptual. They may include qualitative objectives in relation to benthic ecosystems and their biodiversity, or specific quantitative objectives such as a number of hectares to be included within no-take areas, or proportions of available seagrass beds to be protected within no-fishing areas. In identifying such objectives, managers and stakeholders may appeal to the scientific literature, to overseas precedents, to established best practice, or to competent guidelines established by relevant global initiatives and authorities (such as the Marine Stewardship Council (MSC) or IUCN). Such external guidelines may relate to levels of sustainable yield for a harvested species, to preferred and acceptable gear types, to technical procedures for setting catch levels (such as the type of stock assessment model used), to best-practice monitoring and risk assessment procedures, or to stakeholder participation protocols.

Generally speaking, these basic standards (such as a minimum target percentage of area for inclusion within no-take protected areas) will be considered as a minimum external target for an EBM fishery to achieve. Such basic standards will vary depending on location, on life history characteristics of the species being harvested, on the type of ecosystems being fished, on cultural constraints, on national or local jurisdictional policies and rules, and others, and cannot be defined here. However, the preparation of a minimum standard for each of the important components in the fishery management system is an important goal of stakeholder participation, and should be used as the initial focus for stakeholder engagement in an EBM system for fisheries.

One example of the development of national policy into standards of performance for fisheries is provided by the *Australian guidelines for fisheries in the Environment Protection and Biodiversity Conservation (EPBC) Act (1999*). These guidelines are modelled on the MSC approach to performance assessment, and provide a basic set of criteria against which each federally-managed and export fishery must be assessed (see Box 4).

BOX 4

AUSTRALIAN FISHERIES ENVIRONMENT ASSESSMENTS

With the release of *Australia's Oceans Policy* in 1998 the federal government announced its intention to require strategic assessment of the environmental performance of federally-managed fisheries and the removal of the general exemption for export fisheries from the then *Wildlife Protection Act*. The purpose was to ensure that all of these fisheries undergo fishery-independent assessment of their environmental performance. Both these policy commitments are now implemented under the *Environment Protection and Biodiversity Conservation (EPBC) Act 1999*.

The EPBC Act contains a series of provisions with direct impacts on fishery managers and the fishing industry. These require: (1) the strategic environmental assessment *(strategic assessment)* of federally-managed fisheries; and (2) the assessment of the ecological sustainability of export fisheries *(export assessment)* regardless of whether they are state or federally managed. A grace period exists until 1 December 2003 for export fisheries, during which time the assessments must take place. During this grace period the export of most marine species will be unaffected.

The EPBC Act provides that before a plan of management can come into force under the *Fisheries Management Act 1991 (the FM Act) or the Torres Strait Fisheries Act 1984*, the Australian Fisheries Management Authority (AFMA) must: (1) make an agreement for the assessment of the relevant environmental impact of actions under the Plan; and (2) consider any recommendations made by the Minister under the agreement. Agreements must be in place by 16 July 2003 for two-thirds of all federally-managed fisheries for which there are no plans of management in force, and for the remaining one-third by 16 July 2005.

The EPBC Act makes it an offence to harm protected species (cetaceans, listed marine species, threatened species and migratory species) while fishing in federal waters. Fisheries can be exempted if the federal Environment Minister is satisfied that all reasonable steps are being taken to avoid the interaction and it does not affect the conservation status of protected species. These assessments will be done to the extent possible during the export or strategic assessments.

To simplify the development of strategic fishery assessment reports, a set of generic *terms of reference* (TOR) has been developed. The TOR requires information to be provided under the following broad headings:

- description of the fishery.
- the environment likely to be affected by the fishery.
- Proposed Management Arrangements for the fishery.
- Environmental Assessment of the Fishery: to include a comprehensive analysis of the potential impacts of the fishery on the environment, addressing all aspects of the Guidelines for the Ecologically Sustainable Management of Fisheries.
- In particular, the assessment must demonstrate that the fishery is, or is likely to be, ecologically sustainable in terms of its impact on:
  (a) target species.
  (b) non-target species and bycatch.
  (c) the ecosystem generally (including habitat).
- management measures and safeguards to ensure ecological sustainability.
- information sources.

Guidelines for the Ecologically Sustainable Management of Fisheries
In August 2000 the federal Minister for the Environment and Heritage approved the *Guidelines for the Ecologically Sustainable Management of Fisheries*. The Guidelines set out principles, objectives and guidelines for the assessment process. They were developed after extensive consultation with industry, fishery managers and environment groups, and further refined through 'road tests' against selected fisheries.

The Guidelines are the fundamental tool for ecological assessment of fisheries, both for strategic assessment and export fisheries. They are intended to ensure a rigorous and transparent assessment process conducted in close cooperation with fisheries agencies and the fishing industry and providing opportunities for significant input from the wider community.

The *Guidelines* detail the overarching management regime, and set out Principles and Objectives on ecological sustainability.

The management regime

To satisfy the federal government's requirement to be able to demonstrate that a fishery is ecologically sustainable, the fishery must operate under a management regime that meets the *Guidelines*.

The management regime must:

- take into account arrangements in other jurisdictions
- adhere to arrangements established under Australian laws and international agreements
- be capable of controlling the level of harvest in the fishery
- be documented, publicly available and transparent
- be developed through a consultative process providing opportunity to all interested and affected parties, including the general public
- ensure that a range of expertise and community interests are involved in individual fishery management committees and during the stock assessment process
- be strategic, containing objectives and performance criteria by which the effectiveness of the management arrangements are measured
- contain the means of enforcing critical aspects of the management arrangements
- provide for the periodic review of the performance of the fishery management arrangements including management strategies, objectives and criteria
- be capable of assessing, monitoring and avoiding, remedying or mitigating any adverse impacts on the wider marine ecosystem in which the target species lives and the fishery operates
- require compliance with relevant threat abatement plans, recovery plans, the *National Policy on Fisheries Bycatch*, and bycatch action strategies developed under that policy.

The Principles and Objectives

The Principles and the main Objectives set out in the *Guidelines* are summarised below. Under each objective, the guidelines seek information on the information requirements, assessment, and management responses.

Table 1. Principles and guidelines for ecological assessment of Australia's fisheries

Principle	Objectives
Principle 1. A fishery must be conducted in a manner that does not lead to over-fishing, or for those stocks that are over-fished, the fishery must be conducted such that there is a high degree of probability the stock(s) will recover.	**Objective 1.** The fishery shall be conducted at catch levels that maintain ecologically viable stock levels at an agreed point or range, with acceptable levels of probability.
	Objective 2. Where the fished stock(s) are below a defined reference point, the fishery will be managed to promote recovery to ecologically viable stock levels within nominated timeframes.
Principle 2. Fishing operations should be managed to minimise their impact on the structure, productivity, function and biological diversity of the ecosystem.	**Objective 1.** The fishery is conducted in a manner that does not threaten bycatch species.
	Objective 2. The fishery is conducted in a manner that avoids mortality of, or injuries to, endangered, threatened or protected species and avoids or minimises impacts on threatened ecological communities.
	Objective 3. The fishery is conducted, in a manner that minimises the impact of fishing operations on the ecosystem generally.

To provide as streamlined a process as possible, the fisheries assessment report prepared against the *Guidelines* will be used as the basis for decisions in relation to all EPBC Act requirements.

The full *Guidelines* and further information on the federal environmental performance assessment process can be found at **www.ea.gov.au/coasts/fisheries**.

Prepared with contributions from: Environment Australia, Sustainable Fisheries Section.

BOX 5

ECOSYSTEM-BASED MANAGEMENT UNDER THE CCAMLR CONVENTION

The objective of the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR) is the conservation of the living marine resources of the Convention area; conservation is defined to include their rational use. The Convention requires that:

- exploited populations must not be allowed to fall below a level close to that which ensures their greatest net annual increase
- depleted populations must be restored to such levels
- ecological relationships between harvested, dependent and related species must be maintained
- risks of changes to the marine ecosystem that are not potentially reversible over two or three decades must be minimised.

CCAMLR has pioneered an ecosystem approach to fisheries management since the Convention entered into force in 1982.

In common with other international agreements, CCAMLR does not itself impose regulations, but attempts to reach consensus on issues that member states of the Convention are obliged to implement. There are currently 24 Members of the Commission and an additional seven states party to the Convention, but not members of the Commission. Until recently, all nations fishing in the Convention Area have either been Members of the Commission or have acceded to the Convention. The task of managing fisheries has become more difficult since countries that are not party to the Convention, such as Panama, Belize and Honduras, have flagged ships now fishing for toothfish species[5] within the Convention area.

The Commission is the policy-making body that formulates 'Conservation Measures' designed to regulate fishing and other human activities. Management advice is provided by the Scientific Committee, and assessments are conducted by the Working Groups on Ecosystem Management and Fish Stock Assessment.

CCAMLR's ecosystem approach not only focuses on stock management of target species, but also aims to ensure that fishing does not adversely impact on 'dependent and related species'. For example, while krill harvesting is regulated and monitored directly, CCAMLR also monitors the potential effect that harvesting may exert on species that either eat krill or eat krill predators. Thus seabirds, seals and other indicator species are monitored by the CCAMLR Ecosystem Monitoring Program (CEMP). Other environmental parameters, such as hydrographic and sea-ice cover, are also monitored.

CCAMLR seeks to preserve the 'health' of the ecosystem by setting precautionary catch limits for krill that take account of the needs of dependent species and preserve the ecological sustainability of all the species concerned. The Total Allowable Catch (TACs) for the target fish species also are precautionary and tied to TACs for bycatch species, so that a fishery may be closed when the TAC for one of the bycatch species is reached, even if the TAC for the target species has not been fully exploited.

CCAMLR also is attempting to resolve three substantive management problems caused directly or indirectly by the activities of humans:

- incidental mortality of seabirds in fisheries, particularly longline fisheries
- entanglement of marine mammals in marine debris
- impacts of fishing on the seabed.

Unfortunately the problem of Illegal, Unreported and Unregulated (IUU) fishing continues to frustrate CCAMLR's application of the ecosystem approach. Despite considerable success in reducing seabird mortality associated with longline fishing, CCAMLR estimates that more than 100 000 birds may have been killed by illegal and unregulated fishing in the Convention area between 1997 and 1999. In addition, many Antarctic seabirds are killed by longlining operations outside the Convention area.

IUU fishing continues to take substantial quantities of toothfish from the Convention area that are well above the best scientific estimates of the aggregate global limit for toothfish in the Convention area, particularly in the Indian Ocean.

CCAMLR is responding by developing a range of measures, including the Catch Documentation Scheme, that will make it more difficult and less profitable to undertake IUU fishing. However, it will clearly require much greater resolve on the part of governments to eliminate this critical problem.

Adapted from: Kock, K. H.(2000). Understanding CCAMLR's Approach to Management; CCAMLR website ***www.ccamlr.org.***

[5] Patagonian Toothfish – *Dissostichus eleginoides* and Antarctic Toothfish – *Dissostichus mawsoni*

2.4 Ecosystem-Based Management – Elements of success

The elements of successful EBM for natural resources have been distilled from various demonstration projects, technical analyses of science requirements, and from national and regional policies (Sissenwine & Mace 2001, Pirot et al. 2000, Ward et al. 1997, Christensen et al. 1996).

Each of these have stressed the need for *six key elements* to be addressed in the implementation of effective EBM:

- management operates within a *policy framework* designed to facilitate and enable effective implementation of all the principles of EBM
- recognition of *economic, social and cultural interests* as factors that may affect resource management objectives, targets, strategies and activities
- *ecological values* are recognised and incorporated into the management system through developing agreed objectives, targets, strategies and activities that reduce the risk of the impacts of resource exploitation
- information on *utilised species* is adequate to ensure that there is a low risk of over-harvesting and population and genetic diversity are maintained
- the *resource management system* is adequate and appropriate to ensure that EBM can be effective and efficient
- environmental *externalities* that may affect the resource, or that the resource exploitation system may impact, are properly considered within the resource management system.

These key elements need to be expressed and implemented in an EBM management system as outcome-oriented objectives. To be effective and achieve desired outcomes, each objective must have a target (commonly expressed numerically), an implementing strategy, mechanisms for achievement, and rules for determining what constitutes success. In an effective resource management system, each objective would normally be assessed using performance indicators based on quantitative data collected as part of operational management. To implement these elements successfully, they must be supported by an information system including monitoring protocols for the stock and ecosystems targets, with a research component to resolve key uncertainties in the fishery.

The concept of EBM is hierarchical: the operational aspects need to be guided by and nested within the terms of the EBM principles. The linkages however need not be singular, so that a single operational activity may meet the needs of more than one principle. This hierarchical concept is described in Table 2 using a typical (but not exhaustive) set of layers of principles, elements and operational aspects of EBM, and further developed in Table 3 for a hypothetical generic fishery.

Table 2. The hierarchy of components for an effective EBM framework

Principles of the framework	Key elements of the framework	Operational components
1. The central focus is maintaining the natural structure and function of ecosystems, including the biodiversity and productivity of natural systems and identified important species. **2.** Human use and values of ecosystems are central to establishing objectives for use and management of natural resources. **3.** Ecosystems are dynamic; their attributes and boundaries are constantly changing and consequently, the interactions with human uses also are dynamic. **4.** Natural resources are best managed within a management system that is based on a shared vision and a set of objectives developed amongst stakeholders. **5.** Successful management is adaptive and based on scientific knowledge, continual learning and embedded monitoring processes.	**1.** Management operates within a *policy framework* designed to facilitate and enable effective implementation of all the principles of EBM. **2.** Recognition of *economic, social and cultural interests* as factors that may affect resource management objectives, targets, strategies and activities. **3.** *Ecological values* are recognised and incorporated into the management system through developing agreed objectives, targets, strategies and activities that reflect the risk of impacts of the resource exploitation. **4.** Information on *utilised species* is adequate to ensure that there is a low risk of over-harvesting and population and genetic diversity are maintained. **5.** The *resource management system* is comprehensive and inclusive and uses an adaptive approach. **6.** Environmental *externalities* that may affect the resource, or that the resource exploitation system may impact, are properly included within the resource management system.	**1.** Develop outcome-oriented objectives for management activities, i.e. clearly express what the resource management system is attempting to achieve. **2.** Delineate boundaries for the management system, including ecologically defined spatial boundaries, and all relevant ecological and socio-economic factors influencing the productivity of the resource and the integrity of its ecosystem. **3.** Involve stakeholders in all aspects of the management system leading to shared and agreed individual and collective aspirations for the resource and associated ecosystems. **4.** Have a functional information system, including monitoring activities for the objectives and targets, and research activities for the key uncertainties.

Table 3. Implementing EBM in a marine fisheries management system (examples derived from Ward et al. 1997, Ward et al. 2001)

Key element	Expression in the fishery (objectives)	Mechanisms and enabling processes	Performance indicators
1. The fishery operates in an effective policy framework.	**a)** The management system has effective linkages to conservation and socio-economic policies and strategies for the ecosystems where the fishery operates. **b)** The management system appropriately reflects national and international goals and objectives for conservation and sustainable use. **c)** Subsidies and incentives lead to improved EBM outcomes in the fishery.	**a)** Review of regional and national policies and strategies to ensure consistency with EBM principles. **b)** Inter-agency procedures are efficient, effective and accountable. **c)** New subsidies and incentives reviewed by stakeholders to confirm ecological viability.	**a)** The absence of policy inconsistencies that will prevent a fishery from achieving EBM. **b)** Inter-agency cooperation is effective and efficient. **c)** The absence of perverse subsidies and incentives in the fishery system.
2. Social, economic and cultural context of the fishery is incorporated.	**d)** Stakeholders are identified from all areas of relevance to the fishery, and effectively participate in the management system. **e)** The management system and the implementation of objectives and targets are agreed across all stakeholders for both stock management and ecosystem integrity. **f)** Institutional changes result in increased integration and cooperation amongst stakeholders. **g)** Management decisions are based on the long-term social, economic and cultural benefits of the society.	**d)** Procedures are in place for effective participation of stakeholders in all aspects of the management system (such as Management Advisory Committees, Consultative Councils) **e)** Management procedures are publicly accessible, and implemented according to a publicly available plan of management. **f)** Regular review and revision procedures are in place to identify improvements to the management system. This should include professional assessment that is independent of the fishery and management agency.	**d)** The fishery management plan is easily available and is periodically (at agreed regular intervals) open to public review and assessment. **e)** Fisheries status reports that include stock and ecosystem performance reports are periodically (at agreed regular intervals) distributed for public review and evaluation.
3. Ecological values are incorporated.	**h)** Ecosystem values are identified, including ecosystem connections, conservation status, state of ecosystem integrity and critical habitat for utilised and non-utilised species. **i)** Agreed objectives, targets, strategies and performance indicators for enhancing or maintaining ecosystem integrity are developed and implemented. **j)** Achievement of ecosystem objectives is assessed within the fishery management system in partnership with conservation and research sectors.	**g)** Ecosystems have been mapped where the fishery operates, and the conservation status of important species and habitats determined. **h)** Habitats, species and ecosystem function vulnerability to fishery impacts have been assessed, and the targets and harvest strategy adjusted to be precautionary. **i)** Assessment of the fishery performance for ecological objectives is undertaken in conjunction with stakeholders, and procedures and outcomes are made public.	**f)** The ecological integrity of specified sensitive habitats is not declining. **g)** Species considered at high or medium risk from fishing (or their surrogates) are identified and their status used as performance indicators. **h)** Populations of non-utilised (specified) species vulnerable to fishing impacts are not declining. **i)** The bycatch of (specified) protected or otherwise icon species is declining by an agreed proportion each year, or reduced to an agreed level considered acceptable.
4. Knowledge of utilised species is adequate.	**k)** Agreed objectives, targets, strategies and performance indicators for stock status are developed and implemented. **l)** Achievement of fishery objectives is assessed within the fishery management system	**j)** Stock assessments are timely, open to stakeholder participation, and fully transparent and accountable. **k)** Harvest strategies are cautious, and well-buffered against unpredicted failure of	**j)** Target and limit reference points are set at a precautionary level. **k)** Limit reference points for stock size and structure are not violated. **l)** The age structure and natural

Table 3. (continued)

Key element	Expression in the fishery (objectives)	Mechanisms and enabling processes	Performance indicators
	through comprehensive consultative structures established under Key Element 2) **m)** Ecosystem dynamics are fully incorporated into stock assessment models and decisions are cautious. **n)** Effective no-take zones are implemented as 'insurance' against unpredicted failure of the management system in respect of the target stock, associated non-target catch and bycatch, and wider ecosystem values.	assumptions (see Box 18). **l)** 'No take zones' and marine protected areas are designed to benefit both fisheries management and broad ecosystem goals. **m)** Catch levels are set within ecologically defined limits that are understood and agreed.	distributional range of the population are minimally altered. **m)** Stock assessments are open, inclusive and participatory. **n)** No-take zones are agreed and adequately implemented as part of the fishery management system.
5. The resource management system is comprehensive and inclusive, based on reliable data and knowledge, and uses an adaptive approach.	**o)** The fishery management system is structured using ecological classification (such as ecoregions, bioregions, habitat classes). **p)** Baseline data or benchmarks are available for each performance indicator. **q)** Management data is collected for stock management and ecosystem integrity parameters. **r)** Arrangements are in place to facilitate use of data from partner agencies, research collaborators or other sources. **s)** Stock and environmental assessments are conducted in collaboration with fishery operators, partner conservation agencies and other stakeholders e.g. Environmental Non-Government Organisations (ENGOs). **t)** The management system responds to new information and data in a timely and effective way. **u)** Procedures are in place to recognise and adopt new knowledge or data of importance to ecosystem integrity or stock management. **v)** Ecological risks are assessed in a comprehensive manner, and a precautionary decision making framework is used to manage risks. **w)** Gaps in knowledge related to high or medium risks are given priority for research funding and implementation.	**n)** An ongoing research program is in place to improve basic knowledge of the life history characteristics of target species, associated and dependent species and the wider ecosystem where the fishery operates. **o)** The management system includes monitoring to evaluate the status of ecological indicators. **p)** Stakeholders participate in management decisions. **q)** Ecological risks are continuously reviewed to provide for alteration to the harvest strategy as appropriate.	**o)** The amount and type of fishing effort in each habitat class. **p)** Amount and type of bycatch and discards is declining by an agreed proportion each year, or reduced to an agreed level. **q)** Bycatch of protected species is declining by an agreed proportion each year, or reduced to an agreed level. **r)** Research projects reflect the key ecological issues in the fishery. **s)** Comprehensive fishery data monitoring system on targeted species and bycatch is in place. **t)** The amount and type of fishing effort on each level of the population of the target species.

Table 3. (continued)

Key element	Expression in the fishery (objectives)	Mechanisms and enabling processes	Performance indicators
6. Environmental externalities are incorporated.	**x)** Cross-boundary issues are identified, and addressed within the management system. **y)** The long-term dynamics of ecosystems are incorporated into the development of objectives and targets. **z)** The management system considers the full range of human uses and aspirations for the ecosystems being managed.	**r)** Statutory or other procedures are in place to ensure that fisheries managers are involved in management decisions that may affect the stock or the ecosystems where the fishery operates. **s)** Ecological risks and harvest strategies contain measures to assess and incorporate risks from long-term changes in ecosystems or the effects of their uses. **t)** Fishery managers and operators understand and are accountable for their decisions and actions and the impacts of these 'in the water'.	**u)** Critical habitat for the fishery and identified key ecosystem compnents are protected from water pollution, coastal development or other externalities. **v)** Environment protection strategies take into account the use by fisheries of coastal areas. **w)** Allocation of resources for harvest (of exploitable stocks) is made equitably across all legitimate claimants (e.g. requirements of the ecosystem; traditional, subsistence, recreational and commercial fishers) and recognises ecological constraints.

2.5 Performance evaluation

While most theorists, scientists and conservationists generally support the concept of EBM, some argue that the broadening of fisheries management systems to include ecosystem elements will lead to further failure of fisheries management. 'Ecosystem-Based Management of fisheries will tend, we believe, to increase the chances of governance failure. The unfortunate implication is that attempts to implement Ecosystem-Based Management may actually slow progress towards achieving a future of sustainable fisheries.' (Sutinen & Soboil 2001).

This perception is based on the reality that introducing the additional elements of ecosystems and stakeholder participation will make fisheries management considerably more complex. However, fisheries management systems will have to adapt to the new requirements of EBM, or fisheries management will fail, and both fisheries and ecosystems will be seriously at risk. Evaluating the performance of a management system and confirming that it is being effectively implemented is the central aspect of EBM. Given the uncertainty about the pathway ahead, evaluating performance and enabling targeted and flexible adaptability becomes a critical element of any EBM system for healthy fisheries.

Advocates for EBM argue that many fisheries management systems already contain many of the key elements required to achieve EBM, and introducing EBM is not a matter of creating a new management system, but should build outwards from the present system (see for example FAO 2001). However, at issue for most fisheries is the extent to which all the required elements are present, and how well they are integrated and monitored in an effective system for EBM. In order for a management system to evaluate how well it is performing, and to demonstrate that it is achieving its objectives publicly and transparently, modern fishery management systems must include a performance evaluation sub-system.

The performance evaluation should ensure that:

- *performance indicators* are clearly and correctly identified and expressed
- *benchmarks and baselines* are available so that change can be detected at an appropriate level of resolution
- *a reliable data/information capture system* is implemented
- *rules* are agreed for determining what constitutes an important change
- there are opportunities for appropriate technical, stakeholder and public *review and analysis* of the monitoring data and performance assessments.

The effective use of performance evaluation enables the transparent review and assessment of the performance of the fishery in relation to stock and ecological objectives. It also forms a focus for coordinating stakeholder inputs to the fishery's management, and enables the achievements of the fishery to be coherently presented to stakeholders.

An effective performance evaluation is underpinned by scientific procedures, and in some management systems much of this is already built into existing fishery

procedures that measure the populations and productivity of fish stocks. These include the regular stock assessments used to determine future Total Allowable Catches, as well as target and limit reference points. For many objectives of an EBM system the same approach should be used although the information base will often be much more limited, particularly in such matters as habitat requirements and fish ecology including: life histories, breeding biology, migration patterns, distribution, and behavioural patterns in utilised and non-utilised species. Also, the vulnerability of habitats and species to specific impacts of fishing is likely to be highly uncertain. In such circumstances, the risk of the fishery creating a detrimental impact must be assessed (see Boxes 6 and 7). If the risks are high and the impact is important in a particular ecologically or socio-economic context, then fishery operations should be modified until the risks can be more confidently mitigated or assessed.

While new *ecosystem performance indicators* will be needed in an effective EBM system, they will be of a type that is familiar to fisheries managers and should be expressed in the same way as the present fisheries performance indicators, i.e. limit and target reference points against specific ecosystem objectives. While these may not be as fine-scale as the stock reference points used in the more familiar fisheries management systems, and may involve higher levels of surrogacy, they will nonetheless need to be used in the management system in the familiar manner (Sainsbury & Sumaila 2001).

In this way, EBM can 'grow' outwards from existing fishery management systems, albeit with the addition of new ecosystem indicators and their consequent constraints. The most difficult aspects of these ecosystem indicators will be ensuring they are measurable as well as meaningful in terms of agreed ecosystem objectives, and that suitable tools and models can be derived to translate the ecosystem objectives (constraints) into control measures in the fishery. In the interim, decisions will need to be precautionary.

In a comprehensive EBM system a set of performance indicators would fully reflect the intended objectives of the fishery, and include performance measures for all levels in the management system. Table 3 includes a set of example indicators for the objectives provided. The following three boxes reflect three operational aspects of making cautionary management decisions.

Management Strategy Evaluation (MSE) (Box 6) is an approach that builds on the usual management approaches applied in many modern fisheries to include performance evaluation as part of a formal adaptive approach to fisheries management.

Ecological Risk Assessment (ERA) (Box 7) is a process for ensuring all reasonable risks are considered within fisheries management strategies, including risks to ecosystems. It enables risks to be identified, knowledge gaps to be prioritised, indicators of success to be identified and corrective strategies to be designed with the full support of stakeholders.

Ensuring that fisheries can become fully engaged with EBM will at times require some concessions, and a staged approach to implementing the new requirements is likely to be needed. This includes capture of data and knowledge that may be expensive. However, by using a properly planned, scaled and incremental approach, even a small fishery may be able to conduct useful investigations into major research questions, such as evaluating fishery impacts on ecosystems. Box 8 considers the options for collecting data in fisheries of differing capacities for collecting such data.

BOX 6

EVALUATING THE SUCCESS OF MANAGEMENT STRATEGIES

One important aspect of a precautionary ecosystem-based approach to fishery management is to identify harvest strategies that can withstand high levels of uncertainties in scientific understanding about the resource. Fortunately, there are formal methods for pre-testing harvest strategies to identify those that meet explicit management objectives or criteria. These approaches are referred to as testing 'management procedures' and 'management strategy evaluation' or MSE (Smith et al. 1999). They have been applied in specific fisheries in several countries (South Africa, Australia, New Zealand, Iceland e.g. Punt & Smith 1999, Punt et al. 2001).

The *Management Strategy Evaluation* approach involves testing adaptive harvest strategies by simulating the whole management cycle. Key elements in the evaluation include specifying well defined operational management objectives, developing quantitative performance statistics to measure the success in achieving each objective, identifying the harvest strategy options to be evaluated, and simulating the application of each strategy against an underlying 'operating model' of the fishery. The operating model can be made as complex and realistic as possible, unlike the models usually used for stock assessment. A key element of the method is to test strategies for their robustness to a wide range of uncertainties (e.g. in the data used).

Explicitly precautionary strategies can be identified by judicious selection of performance measures (including selection of limit reference points, and acceptable levels of risk of exceeding them), and by testing against realistic vagaries and complexities likely to be operating in the fishery in question. The MSE approach can be applied to a wide range of fisheries, including data-poor fisheries, and to a wide range of management systems.

The MSE approach may be extended to fisheries ecosystem management. The ecosystem objectives must be expressed as outcome-oriented objectives similar to the stock management objectives (Sainsbury et al. 2000).

The best precautionary harvest strategy will be of little use if it is not implemented effectively, assisted by active involvement of stakeholders, particularly the fishing industry, in developing strategies and plans. Smith et al. (1999) point out some of the benefits (and challenges) of implementing an MSE approach in an Australian fisheries management system that involves extensive stakeholder participation. The merits of various forms of 'property rights' are also actively debated. Where existing property rights are diminished or withdrawn, the interest in longer-term resource sustainability diminishes as well, and with it the ability to effectively implement precautionary harvest strategies.

The *key elements* in a precautionary approach to fishery management, and particularly to harvest strategies for individual stocks (leaving aside the wider ecological impacts) are:

1. Recognise the uncertainties inherent in stock assessment methods.
2. Identify and test adaptive harvest strategies prior to implementation using MSE approaches.
3. Test the robustness of strategies to a range of plausible hypotheses.
4. Explore a range of possible management controls (not just Total Allowable Catches). Seek and analyse strategies that may be inherently precautionary (such as gear or fishing areas that select for fish older or larger than age and/or size at maturity; use of no-take areas).
5. Involve fishers in developing and evaluating strategies.
6. Encourage use of fishery-independent surveys of abundance of the target species.

Compiled with contributions from: Tony Smith (CSIRO Marine Research).

BOX 7

ECOLOGICAL RISK ASSESSMENT IN ECOSYSTEM-BASED MANAGEMENT

Ecological Risk Assessment (ERA) is used to provide a focus for the discussion and evaluation of the risks that fishing poses to the ecosystem and its elements. It can be used to identify key ecological impacts of fishing, highlight gaps in knowledge and suggest research priorities to fill those gaps, develop corrective management strategies and actions, and clarify areas of stakeholder disagreement.

An ERA consists of three components, usually conducted in sequence:

1. Current State Description and Problem Formulation

- The ecological circumstances of a fishery are documented (distribution of habitats, and species including threatened/endangered species, etc.).
- Potential ecological concerns are identified.
- Characteristics of the potential stresses (locations and intensity of fishing effort, type of gear used etc.) are identified.
- A conceptual model is derived linking the various aspects of the ecosystem with the potential stress factors, and showing where management may be used to intervene with controls.
- *Assessment endpoints* are determined. These are the indicators used to determine whether the fishery is meeting required objectives. They form the basis for decision rules in the management system.

2. Analysis

- Exposure to the stresses (such as linking distribution of fishing effort to the distribution of sensitive habitat) is characterised.
- The *potential* responses of ecosystems to the stress (such as trawling too frequently and inhibiting recovery of seabed fauna) are characterised.
- The hazards to ecosystems resulting from the stress are identified. This considers effects on the fauna, including indirect impacts on ecosystems, such as changes in species composition.

3. Risks Characterised

- Field data is synthesised to determine likely effects and uncertainties (using available data to attempt to assign actual risks that occur in a fishery).

Adapted from: Guidelines for Ecological Risk Assessment. (Published on May 14, 1998, Federal Register 63(93):26846-26924). U.S. Environmental Protection Agency, Washington, DC.

BOX 8

SCALED INFORMATION AND DATA SUPPORT – OPTIONS FOR COLLECTING DATA IN SMALL-SCALE FISHERIES

In both government-regulated and small-scale community fisheries, only limited management support and often even less research and monitoring support are provided. In the practical world of fishery management, much research, data and information is funded by the fishery itself. For many fisheries, management information is not collected at all (Mathew 2001).

In an EBM system, decisions will often require improved knowledge and data (such as better knowledge about ecosystems) to be able to make appropriate decisions so that the impacts of fishing may be more clearly identified. Gathering such data and knowledge is likely to be very expensive. While some fisheries will have the internal structures and financial capacity to pay for such research (and may already be conducting some of the relevant research), there are many that are either inadequately structured, or financially unable, to support such research. Such fisheries may include small-scale fisheries, fisheries for low-value products, fisheries in economic disarray, or fisheries where it is not acknowledged that some types of research (typically environmental research) are required. For some fisheries, the questions and uncertainties are of such scale that research will need to be undertaken with funding from more than one source.

In the circumstances where the capacity of a fishery to fund extensive research is limited, a number of options exist to gather appropriate types of data and information for use in an EBM system. The options include collaboration with other fisheries in the region or globally where there may be similar issues to be addressed, possibly in collaboration with other sectors such as the conservation sector.

Also, a fishery may adopt an incremental approach to data gathering and research accompanied by highly cautious management objectives and targets (similar to the incremental ‘crossword approach’ of Mathew 2001) provided realistic targets for progress are set and achieved. While not all fisheries would be able to afford major research programs, nonetheless under an EBM system all fisheries are expected to undertake a relevant level and type of research and monitoring matched to the fishery’s financial capacity and the importance of the issues in the fishery.

It is important to encourage fishers, large or small, to regularly collect data on catch and other environmental data. Fisheries where this is part of normal operations demonstrate the pride many fishers take in doing this and the depth of their knowledge and understanding of fishery and ecosystem dynamics. As long as the EBM framework provides a framework for collecting this data and an independent periodic assessment of validity, there are important financial and cultural reasons for fishers being directly involved in data collection.
It is possible that some financially marginal fisheries might be unable to accommodate such research or data collection. In these circumstances, where the viability of a fishery is doubtful, a major reduction in effort or fishery closure might be inevitable. This might be necessary to ensure that fishery ecosystems are properly managed, and that ecological (long-term) costs are not traded-off for the economic (short-term) benefits of an unsustainable fishery. In such situations, economic and social costs need to be fully investigated and alternative economic activities provided to those who would be disadvantaged. In the situation where a marginal fishery must be maintained for socio-economic reasons (such as many artisanal fisheries) the collection of management data may need to be undertaken and financially supported by governments to ensure that these fisheries can be modified to meet the principles of EBM.

2.6 EBM in Fisheries Is Not…

Finally, in articulating what Ecosystem-Based Management for marine capture fisheries entails, it is useful to identify both what it does not include and what should not be omitted from any management system seeking to implement the ecosystem-based approach (see Table 4).

Table 4. EBM in fisheries is Not…

Free of policy context	EBM is not conducted in the absence of guiding principles and policy, set by the competent authorities and relevant communities. Such policies will deal with the broader issues that might have a bearing on the fishery, such as global conventions and treaties, national policies and strategies, and local policies, customs and practices.
Free of social and cultural context	EBM is not effective if it is conducted without careful consideration of social and cultural constraints and issues, and will not be effective if ethical and traditional issues in a fishery are ignored. These matters also cover cultural traditions and social issues like regional employment, human well-being, social fabric and small communities.
A species approach to management	EBM is not about 'single-species' or 'multi-species' approaches to management within fisheries. Nor is managing only those species classed as 'living marine resources' a valid interpretation of EBM. The management of a target stock is not the sole purpose. Related and dependent species including predator fish, seabirds and marine mammals, and habitats that may be affected by fisheries, are all within the framework of an effective EBM system. Similarly, EBM is not solely directed to management of a small number of species that may interact with each other in the ecosystem in which the fishery operates. For example, where a fishery may be influenced by predators on the target species, if the management system does not consider all relevant species, but focuses on a small subset of interacting species with specific commercial, symbolic or cultural interest, it should not be considered an attempt to implement EBM. The essence of EBM is the recognition that maintaining the natural structure and function of all levels and components of ecosystems is the central purpose of management.
Ecosystem impacts on fisheries	In fisheries, EBM is not solely aimed at understanding the influences of ecosystem or environmental factors on the fishery, for example adjusting catch and effort to maintain a pre-determined level of breeding stock in the face of fluctuating oceanographic conditions that affect recruitment of juvenile fish. This is only one aspect of EBM. Many fisheries management systems use environmental and ecosystem information, models and data to develop and implement control and compliance regimes, but such systems are not necessarily comprehensive enough to comprise or achieve EBM.
Only about declaration of protected areas (MPAs)	Refuges and managed areas should play a key role within a broader management framework that endeavours to achieve sustainability for the oceans globally. MPAs will contribute to achieving sustainability, but global sustainability can only be achieved through carefully managing uses in all ocean areas, combined with the dedication of selected areas as complete refuges from exploitation.
In isolation from external influences	EBM does not fail to take account of external influences on a fishery. Such externalities might be harvesting of the same stock by another fishery sector (such as a recreational or traditional fishery or a fishery with other gear types), or the gradual degradation of near-shore habitats by coastal development and water pollution. Harvesting fish by an IUU component of a fishery is not ignored in an effective EBM system, and harvest levels are precautionarily set to take predicted illegal catch into account while measures to control IUU catch are implemented.
About rebuilding damaged ecosystems	EBM is not restricted to the rehabilitation of damaged stocks, degraded ecosystems, or reducing the effects of coastal pollution. These activities may prove to be a high priority for a fishery, but they should be conducted within the context of a strategic approach that is comprehensive and has objectives consistent with EBM. This applies especially where rebuilding may be the major activity required in a fishery, so that the effects of rebuilding on associated and dependent species, habitats etc. are all properly considered in the management plans as levels of stock and effort increase.
Free of stakeholder participation	EBM is not likely to be effectively implemented if it is conducted within an environment of a limited range of stakeholder interests. For example, a management system for migratory fish that only involves some of the nations targeting the species and/or omits stakeholders from relevant organisations is unlikely to be effective EBM.

3 EXISTING MEASURES AND INSTRUMENTS

This section provides a brief overview and some examples of the existing measures contributing to, or obstructing, the achievement of Ecosystem-Based Management of fisheries. There are many measures and instruments that operate to provide support for some of the principles of EBM, but none of them are sufficient to fully implement EBM on their own, even though they may have good aspects that make an important contribution to EBM for fisheries. The examples of existing measures and instruments are categorised into the six elements identified in Table 2:

- *policy framework*
- *socio-economic*
- *ecological*
- *utilised species*
- *management systems*
- *externalities.*

A number of measures have been implemented around the world with a view to achieving Ecosystem-Based Management. However, more often than not such measures have been initiated in reaction to problems created by failures to achieve sustainable fishing practices. They include measures to reduce the problems of bycatch, conflict between users, over-capitalisation in a fishery and polluting practices. Many of these measures would not be required, or would be required only minimally, in sustainable fisheries managed using comprehensive EBM principles.

A major challenge is establishing the mechanisms that allow for integration and rationalisation of the existing measures. National and regional planning and management programs need to provide an integrated effective framework within which fishery-specific objectives and targets can operate to achieve EBM outcomes. Equally challenging is ensuring that the priorities and concerns of local communities are incorporated and addressed at the larger-scale organisational levels.

Table 5 identifies a number of existing measures and the organisational level at which they are delivered, namely *global, regional, national* and *fishery-specific*. They represent a mixture of voluntary and legislative instruments.

Notes to Table 5.

Policy framework: These frameworks generally enable the sustainable use of resources, or facilitate cooperation between interested parties, particularly between nation states or between agencies within a national government. They include a range of legal instruments as well as strategic policy commitments.

Socio-economic: Governments provide a range of economic incentives and subsidies to encourage the exploitation of resources. For the fishing industry these may include vessel building subsidies and exemption from fuel taxes. Financial assistance schemes have been introduced to reduce fleet sizes in particular fisheries. Some governments are now considering incentives such as tax concessions to facilitate the uptake of technologies that reduce environmental impacts.

Ecological: A variety of legal frameworks, management regimes and research programs are in place that endeavour to improve our understanding of the components and functioning of marine ecosystems and the impacts of human use. Many of these provide mechanisms to conserve biodiversity, critical habitats and cultural and amenity values.

Utilised species: A variety of agreements, management arrangements and research programs exist in many fisheries and contribute to an improved knowledge of the populations of utilised species.

Management systems: In many countries fisheries management agencies implement a range of management systems addressing issues such as control of effort, consultation with stakeholders, reduction in bycatch, use of vessel monitoring systems and protection of critical habitats and species.

Externalities: Fisheries can be affected by a range of external influences including coastal development, land-based and ship-sourced pollution, and introduced organisms as well as the inadequately or uncontrolled activities of other users of marine ecosystems including fishing by other sectors (e.g. subsistence, recreational, tourism).

Table 5. Some of the instruments and measures currently in place that can contribute to EBM

	Global	**National**	**Regional**	**Fishery-specific**
1. Policy framework	• 1982 UN Convention on the Law of the Sea	• Various regional seas agreements • Convention on the Conservation of Antarctic Living Marine Resources • OSPAR Convention for the Protection of the Marine Environment of the North-East Atlantic • EU Common Fisheries Policy	• 1998 Australia's Oceans Policy • Canada's Oceans Act • New Zealand's Ministerial Oceans Taskforce • US Oceans Commission • National fisheries legislation • Strategic Environmental Assessments	• South East Trawl Fishery Ecological Advisory Group (Australia) • Research and Environment Committee of the Northern Prawn Fishery Management Advisory Committee (Australia) • Aquatic Environment Working Group (NZ)
2. Socio-economic	• UN Commission on Sustainable Development	• EU Financial Instrument for Fisheries Guidance	• A range of penalties, fees, subsidies and incentives	• Restructuring • Quota Management • Ecolabelling - Marine Stewardship and Marine Aquarium Councils
3. Ecological	• 1993 Convention for Biological Diversity • IUCN Red List • Agreement on the Conservation of Albatross and Petrels	• European Commission Habitat and Birds Directives • Migratory bird flyway agreements	• Threat Abatement Plans for threatened species • Marine Protected Areas • Threatened species listing	• Restoration of ecosystems • Ecological assess ment & independent certification • Closed areas/times • Traditional closures e.g. ra'ui (Polynesia)
4. Utilised species	• 1995 UN Agreement on Straddling Stocks and Highly Migratory Species	• The Convention for the Conservation and Management of Highly Migratory Fish Stocks in the Western and Central Pacific Oceans. • Convention on the Conservation of Southern Bluefin Tuna	• National quota allocations given, or to be given under these conventions • The Australian SeaNet program	• Total Allowable Catches • Individual Transferable Quotas • Area closures • Gear restrictions
5. Management systems	• 1995 FAO Code of Conduct for Responsible Fisheries • FAO International Plans of Action	• Irish Sea Cod Recovery Plan • North Sea Commission Fisheries Partnership • Baltic Sea Fisheries Commission	• National fishery management agencies	• Fishery management plans • Bycatch Action Plans • Extension services • Codes of practice • Stakeholder participation frameworks
6. Externalities	• Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matters • United Nations Environment Programme Global Plan of Action for the Protection of the Marine Environment from Land-Based Activities • Convention on the Control of Harmful Anti-fouling Systems on Ships • Ballast water controls	• OSPAR Hazardous Substances Strategy • OSPAR Nutrients Strategy • EU Recommendations on Integrated Coastal Zone Management • EU Water Framework Directive	• Integrated coastal zone management programs • Watershed / catchment management programs	• Water quality monitoring for estuarine and coastal fisheries e.g. river prawns, cockles, rock oysters

In this section we provide short overviews of some of these instruments and initiatives and identify particular shortcomings.

3.1 Policy Framework

Most policy frameworks have two aspects: (1) the legal elements that are in place at all levels of government and (2) the various planning and management arrangements including assessment processes that are delivered at the national or local level of government. However, the existing frameworks have often been developed reactively in response to a variety of needs. Box 9 analyses the international legal framework for the management of fisheries and highlights deficiencies for the implementation of EBM. Box 10 outlines a Strategic Environmental Assessment process to incorporate socio-economic and environmental assessments as well as any cumulative impacts.

BOX 9

INTERNATIONAL LAW

The existing international legal framework for managing fisheries has a number of interlocking components. There is considerable potential for the legal system to adequately support an ecosystem approach to fisheries management. However this potential is not currently fully realised. Indeed, many current arrangements are a barrier to implementing the ecosystem approach to fisheries management at the domestic and regional levels.

The Current System
Existing international legal frameworks do not support integrated approaches to management. The transaction costs of co-operation are also very high due to the over-emphasis on sovereignty. There is no integrated and consistently co-operative approach to managing these cross-boundary resources anywhere in the world. The closest approach so far is the Convention on Conservation of Antarctic Marine Living Resources (see Box 5).

The current system comprises:

- international treaties (bilateral, regional and global instruments) such as the United Nations Convention on the Law of the Sea 1982.
- internationally agreed ‘soft law’ and guidelines such as the FAO Code of Conduct for Responsible Fisheries.
- international fisheries commissions with specified jurisdictional areas on the high seas such as the North East Atlantic Fisheries Commission (NEAFC).
- national legislation and institutions with authority within the 200 nautical mile Exclusive Economic Zone.

Some of the key shortcomings of the current system are:

- Few Conventions designed to manage fisheries and their ecological impacts have a sufficiently broad-based membership to be effective.
- Many treaties and instruments with the potential to support Ecosystem-Based Management are not properly implemented or enforced.
- Most regional fisheries Commissions are species-oriented and generally fail to manage impacts on dependent or associated species, much less the ecosystems that support them.
- Most of the relevant institutions lack adequate resources to undertake their tasks effectively.
- There is inadequate coordination and interaction between existing international agreements and management bodies.
- The agreements fail to fully address and manage serious threatening processes such as marine pollution, marine debris, introduced species and the incremental decline in marine biodiversity.
- The overall logic of the current system ignores the realities of fishery ecosystems and the marine environment, and is only partly responsive to ecosystem requirements.

Prepared with contributions from: Martin Tsamenyi, Kwame Mfodwo and Sali Bache

BOX 10

STRATEGIC ENVIRONMENTAL ASSESSMENT

A variety of practical, analytical and planning tools are available to facilitate the delivery of an ecosystem-based approach to the assessment and management of any ecosystem. These can be broadly divided into two groups: assessment tools and delivery tools. Regrettably, since activities in many ecosystems have already been inadequately managed, resources have been overexploited, damage has already been done and a third group of tools is also required: restoration tools that must operate alongside the assessment and delivery tools.

Assessment tools include Strategic Environmental Assessment (SEA), incorporating both socio-economic and ecological assessment. SEA can involve habitat mapping, risk analysis and sensitivity mapping, and should be used to facilitate decision-making processes for spatial planning. Environmental Impact Assessment (EIA) for specific projects or activities is also important once broader-scale spatial planning decisions have been made.

Delivery tools can be largely grouped under three headings:

- spatial controls, for example, representative networks of protected areas
- level controls, for example, limits on extraction of a resource or on volume of a discharge
- best practice, including appropriate technological advances.

Restoration tools include measures that aim to restore degraded, damaged or lost habitats or wildlife populations, including regeneration areas for fish, habitat restoration and rehabilitation schemes.

The application of all these tools requires flexibility, based on local conditions. Putting these measures in place also requires a decision-making process and ways and means of monitoring and evaluating the success of the measures.

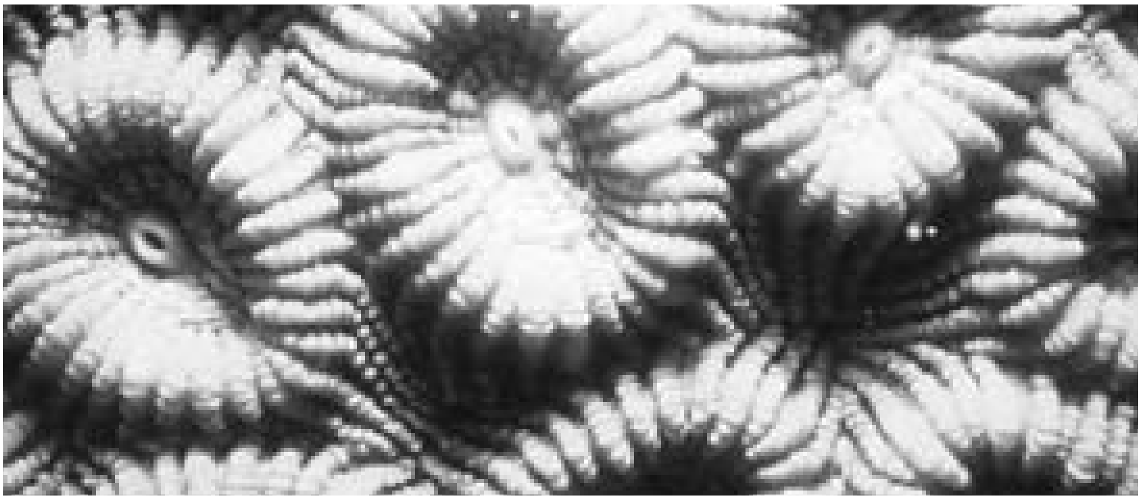
In 1997, the International Offshore Oil & Gas Experts meeting in Noordwijk, the Netherlands recognised:

> 'Prior assessment is important and baseline assessments and studies are valuable to predict impacts. Some parties do not consider environmental impact assessment(s) to be sufficient to determine impacts and believe that strategic environmental assessment is necessary to accommodate cumulative impacts.'

Benefits of SEA

Strategic Environmental Assessment analyses the impacts of policies that may not be assessed within individual projects. Thus, for example, in the context of the development of renewable energy sources, SEA would facilitate assessment of the potential impacts of continued exploitation on non-renewable mineral resources and climatic impacts of burning fossil fuels.

SEA encourages consideration of environmental and social objectives at all levels including policy development, plans/programs and specific project activities. It facilitates consultation between authorities and enhances public involvement in evaluating the environmental aspects of policies, plans and projects. It can also make some Environmental Impact Assessments (EIAs) redundant if the impacts of a new project are fully assessed at the SEA stage.



BOX 10 cont.

STRATEGIC ENVIRONMENTAL ASSESSMENT cont.

SEA encourages consideration of alternatives not practical at the project EIA stage and allows mitigation measures to be formulated for later projects. Perhaps most importantly, in facilitating spatial planning decisions, SEA helps determine appropriate sites for projects, although in most cases these must necessarily be subject to further more detailed and site-specific EIA.

Unlike EIA, SEA allows effective analysis of cumulative effects and facilitates consideration of synergistic effects. It also allows consideration of long range and delayed impacts. And it enables more effective consideration of ancillary and secondary activities.

An example of the role of SEA
Before an offshore development is licensed, it is important to undertake a strategic approach to the planning of all offshore developments and activities. A SEA process allows strategic decisions to be taken about the placement of offshore developments in the context of other human demands on a regional marine ecosystem. Through SEA it also is possible to identify and protect those areas which are considered to be too sensitive to the risks associated with offshore oil and gas development.

The development of 'preferred' areas of activity should still remain subject to comprehensive Environmental Impact Assessments (EIAs) although the SEA will have informed the EIA process. Conditions on licenses and regulations to minimise discharges should reduce the risks associated with development. Monitoring and feedback loops in the assessment process are necessary to ensure that predicted impacts are negligible. Note that SEA should also include an assessment of government and industry policies with respect to continued development of the offshore environment for non-renewable resources.

Prepared with contributions from: Sian Pullen (WWF UK).

3.2 Socio-economic Initiatives

Ecolabelling
In recognition of the increasing trend towards rights-based systems intended to promote a sense of custodianship in fishers, ecolabelling has been proposed as a mechanism for monitoring, improving and rewarding healthy and well-managed fisheries.

Ecolabelling for fisheries is intended as a market-based incentive to enable consumers to recognise responsibly produced seafood. The leading ecolabelling program for marine capture fisheries is the certification and labelling scheme operated by the Marine Stewardship Council (Box 11). WWF is also working with a number of small-scale fisheries to develop a community-based application of this approach (Box 12).

BOX 11

MARINE STEWARDSHIP COUNCIL

The Marine Stewardship Council (MSC) is an independent, global, non-profit organisation based in London. The MSC is seeking to harness consumer purchasing power to generate change and promote environmentally responsible stewardship of the world's most important renewable food source.

Consumers concerned about overfishing will increasingly be able to choose seafood products independently assessed against the MSC Standard and labelled to prove the product's compliance. This will assure them that the product has not contributed to the problems of overfishing or fishing-related destruction of habitats or declines of endangered species.

The MSC was established in 1997 by Unilever, the world's largest buyer of frozen seafood, and WWF, and has operated independently since 1999. The MSC brought together supporters from more than 100 organisations in over 20 countries. Crucial to the MSC is that it must operate openly and transparently. The MSC program only works using a multi-stakeholder partnership approach, taking into account the views of all those seeking to secure healthy and well-managed marine ecosystems.

Central to the MSC are the *'Principles and Criteria for Sustainable Fishing'* developed through an unprecedented international consultation with those involved with fisheries management. Fisheries must be independently assessed against these Principles and Criteria and if successful can apply to use the MSC logo. Since the first certification of the Australian Western Rock Lobster fishery in March 1999, five more fisheries have been certified[6], and many more are either seeking full assessment or are addressing the issues identified at the first 'pre-assessment' stage.

The MSC Principles cover three areas: the state of the stock, the state of the ecosystem in which that stock exists, and the state of the management system governing the fishery. The Criteria address specific aspects of sustainability. The MSC Principles and Criteria, through providing clear operational guidance and a 'way ahead', are making an important contribution to achieving EBM. In addition, through the MSC process of initial assessment and annual audits, stakeholders can contribute to improvements in the fishery management by providing their concerns to the auditors.

For procedures for stakeholder engagement, details of current certification procedures and a list of certified fisheries or fisheries currently undergoing full assessment see **www.msc.org**.

[6] The Thames Herring fishery, the Alaskan Salmon fishery, the New Zealand Hoki Fishery, the Burry Inlet Cockle Fishery and the UK Mackerel Handline fishery.

BOX 12

WWF'S COMMUNITY FISHERIES PROGRAM AND CERTIFICATION IN SMALL-SCALE FISHERIES

Taking into account concerns expressed during the MSC's international consultations, WWF developed a methodology for applying the MSC program to small-scale and developing nation fisheries. WWF believes these small-scale fisheries are among the most critical to biodiversity protection as they are in many of the world's most biologically rich marine areas.

Small-scale fishers comprise approximately 94% of the world's fishers and produce nearly half the global fish supply for human consumption (McGoodwin 1990). Along the world's coastlines, they provide most of the protein and jobs for neighboring communities, yet are more threatened than other fishers by coastal habitat destruction and pollution. The need to maximise short-term economic benefits can encourage unsustainable use patterns, making fisheries vulnerable to over-exploitation, and jeopardising the benefits derived from them. Moreover, fishing practices may damage the marine environment through uncontrolled use of destructive fishing gears and extracting marine species without fully considering biological, ecological and economic criteria for sustainability (Comunidad y Biodiversidad – CoBi – 2000).

Recognising the need to create alternative models for resource extraction that incorporated conservation of fishery resources, protection of the marine environment, and improvement of the livelihood of fishers, WWF initiated its community fisheries program.

WWF's community-based certification initiatives are developed through robust partnerships with local fishers and other stakeholders. Since 1999 WWF has tested its approach globally in more than a dozen community-based fisheries in Africa, Latin America, Europe, Asia and Australia. WWF hopes to demonstrate that MSC certification can provide a powerful incentive for protecting biodiversity in community-scale fisheries while ensuring long-term sustainability both for marine resources and for the human communities that depend on those resources for survival.

WWF believes it is important that the MSC show that certification and ecolabelling can work in small-scale fisheries. Critics have contended that the costs associated with certification may be beyond the means of less wealthy communities, and be difficult where data is limited or of low quality. WWF is working to develop systems to ensure that certification is open to small-scale community fisheries when they seek the potential benefits it can provide them.

Prepared with contributions from: Julia Novy-Hildesley (WWF US).

3.3 Ecological Initiatives

A range of existing initiatives, instruments and measures focus on important aspects of fisheries and ecosystems and need to form part of EBM. These measures include species protection and recovery plans for seabirds and marine mammals, and habitat protection plans for coral reefs and seagrasses. Many fisheries have in-built protection for habitats considered to be critical to sensitive life stages of the harvested species, and some already protect spawning locations and aggregations.

One major topic of considerable current debate is the role of protected areas in enhancing fisheries management, as well as conservation of biological diversity. Many fisheries already include areas closed to fishing to protect stock (such as protection of a spawning or nursery ground). These areas are not always recognised as also contributing to biodiversity conservation.

At present, most focus is on the role of fully and permanently protected 'no-take' areas, where fishing is permanently excluded. 'No take' reserves clearly provide the greatest benefit to biodiversity conservation, but also may provide the greatest benefit to fisheries by excluding all detrimental activities from areas identified as crucial fisheries habitat, such a spawning and nursery grounds (Box 13).

3.3.1 Protection

BOX 13

MARINE RESERVES – THE BENEFITS TO FISHERIES

Fully protected marine reserves are a high-profile, often controversial and well-documented tool for protecting marine ecosystems and the species they support. However, only recently have their benefits to fisheries been properly assessed. There is a growing body of evidence from all over the world about the potential importance of marine reserves in maintaining or enhancing fisheries and marine ecosystems.

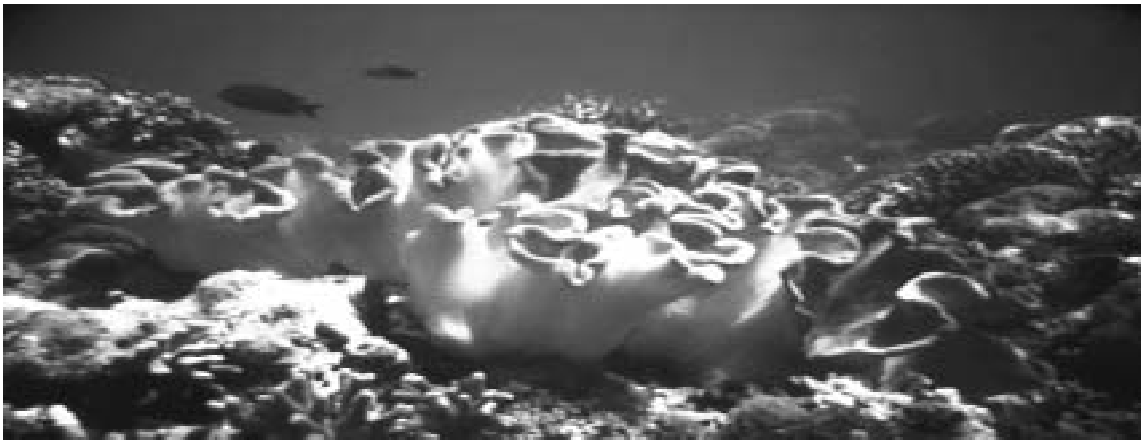
Ward et al. (2001) provide the following summary of global experience in their review of the role of marine reserves as fisheries management tools:

> 'Sanctuaries have the potential to provide most benefit to fisheries that are presently either fully or over-exploited. The benefits to be derived from a sanctuary are made possible by two key bio-physical processes: 'spillover '– the export of adults and juveniles of target species to the fishery; and 'larval export' – the distribution of propagules of the target species into settlement areas, from where they will eventually recruit into the fishery. These benefits to a fishery will depend critically on the life history strategy of the target species, and the design of the sanctuary, including its location, size and shape. The third key benefit that we expect to be derived from fisheries sanctuaries, is 'enhanced fisheries stability'. Sanctuaries provide the basis for a more precautionary and 'bet-hedging' management strategy for fisheries, and this would reduce variability associated with the interaction of fishing and environmental dynamics. The most effective design for optimal benefits is likely to be a network of sanctuaries with a mixture of large and small individual areas.'

While reserves are frequently designed to meet multiple objectives and provide for a range of uses, scientists and conservation advocates emphasise the importance of reserving an adequate area providing full protection (Roberts & Hawkins 2000). Such fully protected reserves can offer a range of benefits including protecting biodiversity, enhancing fisheries, providing economic opportunities and reducing conflict. However, as Roberts and Hawkins note: 'Successful reserves require a great deal of effort to establish followed by long-term commitment from local communities and decision makers to maintain effective protection. Time after time, experience has shown that reserves are unlikely to be successful unless there is close involvement of all stakeholders throughout the full establishment process'.

Marine reserves are integral to the Ecosystem-Based Management approach as they:

- protect habitats and associated biodiversity otherwise impacted by fishing activities, thus contributing to the maintenance of ecosystem structure and function
- allow for the natural dynamics and natural evolution of ecosystems
- contribute to the social and cultural values of local communities
- closely involve all stakeholders.



BOX 14

HIGH SEAS RESERVES

Most marine reserves are in coastal waters or associated with emergent reefs or distinctive emergent landforms such as islands and seamounts. In their recent review of the status of natural resources on the high-seas, Baker et al. (2001) note:

> 'Approximately 50% of the Earth's surface is occupied by High-Seas areas – open ocean and deep-sea environments lying beyond the 200 nautical mile limit of the Exclusive Economic Zones of coastal states. These high-seas areas are open-access common resources, and as such may be particularly susceptible to over-exploitation. Until relatively recently there was little perceived threat to these areas. However, in recent years there has been a rapid expansion in two industries (demersal fishing and hydrocarbon production) that can currently operate down to water depths of at least 2,000 m. These operations pose a potential threat to the deep-sea environment of high-seas areas. There are also a number of existing threats to open ocean areas, e.g. direct and indirect impacts on fish, seabirds and cetaceans. Further, there are a number of suggested or developing technologies that could pose a threat to high-seas areas, e.g. CO_2 dumping, biotechnology, deep sea mining, the exploitation of gas hydrates and hydrothermal vent heat energy.
>
> It is therefore timely to review the status of natural resources in high-seas environments in light of these existing or potential threats. Deep-sea and open ocean environments are continuous and highly interconnected, however, there are a number of relatively discrete or localised geographic features, habitats and biological communities that have particular scientific, societal or economic interest.'

These include hydrothermal vents, deep-sea trenches, polymetallic nodules, gas hydrates, seabirds, transboundary fish stocks, seamounts, deep-sea coral reefs, cold seeps and pockmarks, submarine canyons, upwellings and cetaceans.

The opportunities and difficulties in establishing high seas reserves are being actively discussed. While international law does not necessarily obstruct the establishment of high seas reserves (de Fontaubert 2001), there are considerable challenges in getting support from a majority of States to agree to management and enforcement regimes that will meaningfully manage human impacts on high seas ecosystems.

3.3.2 Restoration

In many places, ecosystems of importance to fisheries have become highly degraded by fishing and a range of other factors such as the effects of coastal pollution and loss of habitat through land reclamation. These ecosystems need to be restored so that they can be again valuable for fisheries and for the conservation of biodiversity. Ecosystem restoration is a highly complex area. Most restoration efforts focus on removing the immediate threats to ecosystems, and enabling natural recovery where possible. There are also important initiatives underway to demonstrate the economic and ecological benefits flowing from the restoration of degraded ecosystems (Box 15). One important aspect of justifying the need for restoration projects is discounting present-day costs as they relate to benefits that will be derived by future generations (Box 16).

BOX 15

ECOSYSTEM RESTORATION

The collapse of many of the world's coastal ecosystems and fisheries (Jackson et al. 2001, Watson & Pauly 2001) means that in the shift towards EBM, fisheries managers must consider how to incorporate objectives for ecosystem restoration into their fishery management systems. While fisheries are only partly responsible for the failures of coastal management, the effects of fishing have played an important part in the collapse of coastal ecosystems (Jackson et al. 2001), and fisheries management and the fishing industry must now collectively begin the painstaking process of assisting to rehabilitate ecosystems. This is not only for the ecological values, but also for the long-term sustainability of the social and economic values derived from these ecosystems.

Back to the Future

Specific processes and procedures that can be implemented in fisheries management to achieve ecosystem restoration are unclear. The ecological processes leading to fishery-induced changes in ecology seem to be ratchet-like, and difficult to reverse (Pitcher 2001). But scientists and others now suggest that rebuilding ecosystems to a past healthy state, rather than attempting only to achieve sustainability of the harvested stock, should be the proper goal of fishery management (e.g. Pitcher & Pauly, 1998). To achieve this, a 'Back to the Future' (BTF) approach has been developed. The BTF approach captures the social, economic and cultural aspects of fishing and, at the same time, comprehends the role and 'services' provided by non-exploited as well as 'commercial' elements of marine ecosystems (Pitcher & Pauly 1998). The intention is to optimise the ecological, social and economic benefits from restoring ecosystems.

The BTF approach combines multi-species, ecosystem-based modelling with economic evaluation to develop rebuilding and management strategies. The key element of this approach is the ready availability of modelling tools to construct snap-shots of specific ecosystem attributes and explore modelled scenarios at various points in time. With a range of ecosystem modelling tools and suitable data, this approach permits various options for achieving desired ecosystem goals to be explored. Model robustness is ultimately tested by comparison with data provided by the fishery information system, and 'ground-truthing' by support studies.

With appropriate modelling tools, marine ecosystems of the past can be simulated by combining information from local and traditional knowledge, historical archives, the oral history of fishing communities, archaeological records, and published and unpublished literature. A wide range of fishery stakeholders can be involved. Past marine ecosystem models can be compared with the present-day ecosystem and the ecological and economic benefits from restoration can be quantified. Effects of different management policies for ecosystem restoration on biodiversity and resource abundance can be simulated and the different ecological, economic and social benefits of different courses of action compared. The results can help formulate fishery management plans that work towards achieving common conservation and restoration goals.

An approach similar to the BTF project may also be appropriate to design objectives and targets to achieve broader ecosystem restoration objectives in fisheries. These could include habitat integrity, species diversity and function, and specific targets for key non-harvested species such as threatened and endangered species. With this approach, fisheries can make an important contribution to setting ecosystem goals and objectives both within a fishery and more broadly for activities designed to help ecosystems recover from the impacts of other human uses. The ecosystem modelling requirements are complex, and at present only simple models can be implemented, but even simple representations of ecosystems can assist to resolve these issues.

BOX 16

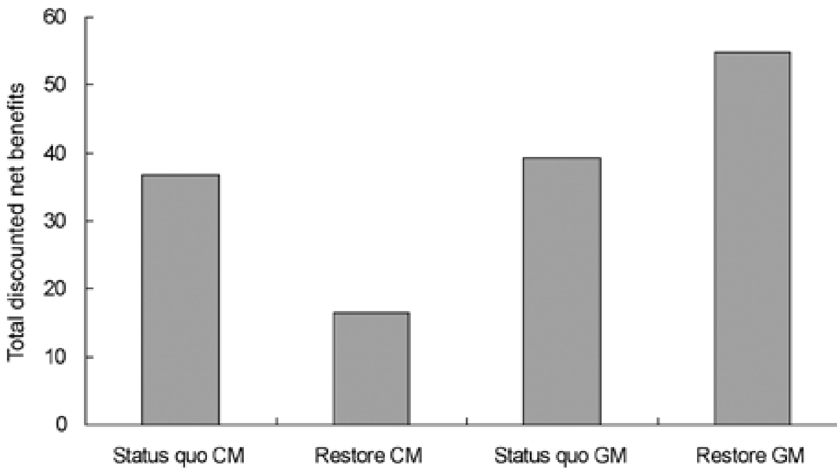
GENERATIONAL COST-BENEFIT ANALYSIS

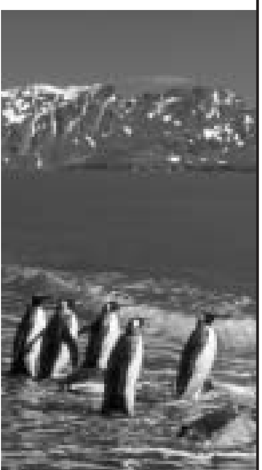
In assessing the projected benefits in relation to present-day costs, recent work suggests that it is important to use realistic assumptions in any underlying models. Economists argue that ecosystem restoration projects should be evaluated using cost benefit analysis (CBA). But conventional CBA is inadequate to evaluate projects designed to restore depleted marine ecosystems and fisheries (Sumaila 2001). Discounting at prevailing rates reduces benefits that accrue in the distant future down to almost nothing. (Sumaila 2001) proposes a different approach to CBA, denoted *Generational* CBA.

This new approach discounts the flows of costs and benefits from the perspective of all generations, both current and future. While the conventional CBA discounts the costs and benefits from restoration efforts using only the time perspective (denoted by the discounting clock) of the current generation, Generational CBA takes into account the fact that current restoration efforts may produce benefits to future generations, long after present generations cease to exist. Benefits to future generations need to be valued properly by discounting the flows of net benefits to each generation using their respective discounting clocks. In this way more realistic benefits can be projected, and the returns more realistically evaluated in the context of present-day costs. Typically, benefits are much higher under the Generational CBA than under conventional CBA, and the restoration of ecosystems appears to be much more cost-effective.

The following graph shows the modelled net benefits to a fishery from investing in ecosystem restoration, with benefits assessed using both CBA (CM) and GBA (GM) for two options – maintain the status quo (do not invest in restoration) and invest in restoration. Restoration clearly provides greater benefits when assessed using the GBA approach.

Both Boxes 15 and 16 prepared with contributions from: William Cheung (WWF Hong Kong), Eny Buchary, Ussif Rashid Sumaila and Tony Pitcher (University of British Columbia Fisheries Center).





3.4 Utilised species – Total Allowable Catches and Individual Transferable Quotas

Species targeted for exploitation, or taken in a fishery incidentally to the main target species, are usually the subject of controls established to maintain viable populations, and to ensure the ongoing bio-economic viability of the fishery. In an EBM system decisions controlling fishery actions in respect of the target species must be cautious and cater for errors (or failures in models or assumptions) in the management system that could lead to overfishing or to an unacceptable level of ecological impact. In this section, two key EBM issues in relation to stock management are discussed: (1) setting precautionary catch levels (Box 17); and (2) the role of quotas in managing and allocating harvest rights (Box 18).

There is considerable interest globally in developing property rights for fishers, and applying them in a precautionary manner. The *Individual Transferable Quota* (ITQ) approach used in several countries (including Iceland, Australia and New Zealand) suggests a set of incentives to encourage fishers to behave responsibly. Profitable fishers are in theory more flexible, can afford to consider and invest in stewardship activities, and are able to make short-term sacrifices in 'the interests of longer term sustainability', such as investment in improved gear and training of crew to release threatened species from nets. ITQs are a promising tool for assisting fishers to become better stewards of the fishery resource they manage, but there are few well-documented examples of this theory becoming reality. Also, while ITQs are the most popular approach to allocating and managing property rights for fishers, they are only one type of 'right' on the spectrum of access to fishery resources. Territorial use rights (TURFS), traditional access rights, licence systems, annual catch entitlement, and more, are all means of allocating access to fishery resources.

The ITQ system, although currently the most popular form of rights allocation, has two important disadvantages in terms of ecosystem sustainability that are yet to be resolved. The ITQ system assumes that fishers will have a higher incentive to properly manage stocks over the long term to maintain the value of their right to fish. An ITQ allocates to a fisher a proportion of the total catch permitted for a season or year. However none of the ITQ systems have successfully linked the rights allocation to an effective realization of the coupled environmental responsibility, and the right to fish has had to be supplemented with other forms of control (often input controls) to minimise the environmental impacts of fishing. However, the appeal of an ITQ fisheries management system is the perceived simplification of the associated management procedures, i.e. reducing other controls, reducing government supervision, and reducing the costs of management overheads such as monitoring and compliance. However, given the operational difficulty associated with linking environmental responsibility to ITQs, it is not yet clear what role an ITQ system would have in fisheries EBM if it is *not* supplemented by other controls designed to minimise ecosystem impacts. How such controls might work in conjunction with ITQs and how effective such a hybrid system will be, have yet to be properly evaluated.

The second major concern about ITQs is the possibility of concentration of rights into the control of just a few owners. If they treat fisheries as a normal business venture, without accepting the responsibility for conducting the fishery business in a sustainable manner, these owners can always exercise the option to move on to other business ventures if the fishery fails. While such concentration of power in the hands of a few is a risk, it can also be a benefit where the owners are long-term fishing companies with a strong commitment to sustainable fishing. The concentration of control that may be permitted by an ITQ system therefore can be either a threat or a benefit, depending on the culture and commitment of the rights owners to fisheries sustainability. It seems unlikely that an ITQ system will ever be able to be free of government control over ownership of rights, or without control over the environmental impacts of fishing activities, and at least one of the postulated benefits of ITQs (minimal government controls) will not be able to be achieved without risking fishery sustainability.

BOX 17

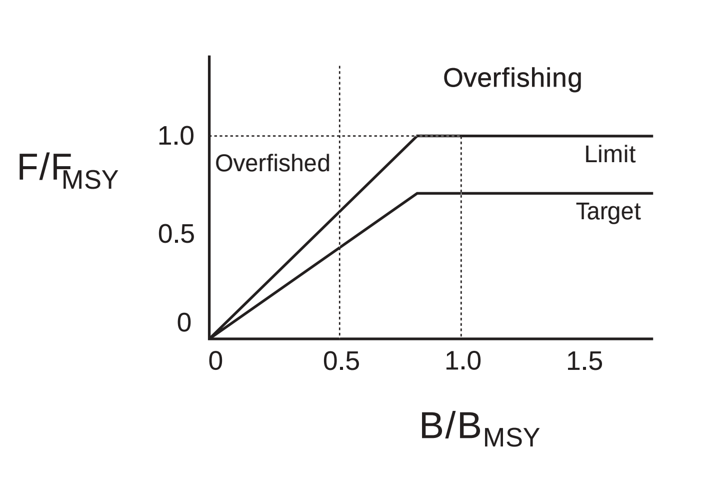
PRECAUTIONARY DECISION RULES FOR SETTING TOTAL ALLOWABLE CATCH

Despite general agreement on the need for, and basic principles of, a precautionary approach to fisheries management, practical implementation has been slow to develop internationally. Most fisheries are managed without using agreed decision rules that dictate, for example, the exact form of response when a target or limit s reached. Even where formal quantitative stock assessments are available, decisions about Total Allowable Catch (TAC) are often made taking into account a range of 'other factors', particularly economic and social considerations (such as the immediate impacts on profits, jobs and fishing communities). To implement EBM in fisheries, any TAC must be set in a precautionary way, and should always be based on a clear set of decision rules.

A *decision rule* should specify exactly what management action is chosen under a given set of circumstances. Decision rules can be simple, for example using a constant proportion of the current stock size; or more complex, for example taking account of uncertainty in the estimates of stock size. The most precautionary decision rules for setting TACs take account of uncertainty in estimates, and are flexible and responsive to different conditions in ecosystems and in the fishery.

In some cases, TACs for different species in a multi-species fishery may be linked (to avoid excessive discrepancies and 'dumping' problems). Fisheries may be closed if catch limits for particular bycatch species (especially protected or threatened species) are exceeded. The setting of cautious TACs could also relate to the requirement for a particular pre-determined species mix in the catch in a fishery, or to specific ecological performance objectives in a particular region. Although any decision rule is possible, it must be (1) clearly specified, (2) tested to ensure it meets agreed standards, and (3) formally agreed and implemented.

An example of a formal and explicitly precautionary decision rule is that suggested for US fisheries by Restrepo et al. (1998). This was designed to be a generic or default rule to apply to stocks in a wide range of fisheries. It incorporates explicit definitions of both 'overfishing' (*excessive fishing mortality rates*), and 'overfished' (biomass too low). Overfishing is defined as a fishing mortality rate in excess of F_{MSY}, while overfished is defined as a biomass below 0.5 B_{MSY} (F is the Fishing Rate, MSY is Maximum Sustainable Yield, and B is the biomass).



The target decision rule is designed to provide a low probability of both overfishing and being overfished. Although unspecified, it relies on a method of stock assessment to estimate F, B, F_{MSY} and B_{MSY}. While it does not have a specific ecosystem component, this could be included. This particular form of decision rule uses MSY as a Limit Reference Point and could be adapted to link ecosystem objectives and the TAC in a fishery where EBM was fully implemented. It could also be designed to take account of the specific needs of associated and related species, habitats, top-level predators, or threatened species.
(Diagram after Restrepo et al. 1998)

Prepared with contributions from: Tony Smith (CSIRO Marine Research).

BOX 18

THE RIGHTS TO FISH – AN ECOLOGICAL CRITIQUE OF INDIVIDUAL TRANSFERABLE QUOTAS

Individual Transferable Quotas (ITQs) are exclusive and transferable rights to harvest a given portion of the total allowable catch of fish. They are one form of 'rights-based management' used to manage the allocation of resources and interactions between users of marine ecosystems. Fishery managers establish total allowable catch levels (TACs), and divide this among individual fishers or fishing companies in the form of individual harvest quotas, usually a percentage of the TAC. ITQs are transferable by being sold or purchased on the open market. In theory, ITQs create *de facto* property rights.

If effective, ITQs are designed to remove the drive to 'race for the fish', and create an incentive among fishers to regard the fishery resources as assets that can deliver economic benefits over the long run if responsibly managed. Hence, the tendency on the part of fishers to over-exploit the resource should be reduced. Well-functioning ITQ schemes may also encourage fishers to collect and disseminate relevant biological and harvest quota data (Walters & Pearse 1996). This would tend to improve the quality of stock assessments, which could lead to more certain and perhaps increased TACs.

What can ITQs accomplish?
The practical use of ITQs in fishery management often is questioned. The strongest point against ITQs from a conservation perspective is that ITQs are based on harvest quotas, which rely on estimates of the abundance of the resource stock. The uncertainty of these estimates, if not properly addressed, can lead to stock collapse irrespective of the quality of the ITQ scheme in place. Some argue that a badly designed ITQ scheme may be worse than no rights-allocation scheme at all.

For the data-poor artisanal fisheries typical of species-rich tropical waters, there are serious doubts about the usefulness of ITQ schemes, partly because of the problems of bycatch. Fisheries anthropologists are probably the strongest critics of ITQ management, arguing that whatever the potential benefits of ITQs, they are contrary to principles of equity and social justice in fishing communities, and are therefore not appropriate for certain fisheries.

What have ITQs accomplished?
Many studies of ITQ systems in operation around the world demonstrate that economic efficiency does improve with the implementation of ITQ schemes. There is evidence from Australia, Canada, Iceland and New Zealand that ITQs have improved economic efficiency and increased returns to fishers (Grafton 1996). Hannesson (1996) considers that ITQs are primarily an instrument for promoting economic efficiency rather than conservation, or equity. If economic efficiency was the main issue with ITQs, it could be concluded that ITQs have achieved their objective. However, a review of the literature on ITQs shows that fisheries scientists are preoccupied with conservation and social concerns, and the associated trade-offs against economic gains.

Problem areas for ITQs
Stock Assessments: As predicted by Walters and Pearse (1996) and others, uncertainties in determining TACs could undermine even some of the most well-documented ITQ schemes. A case in point is the collapse of the Icelandic cod stocks in 2001.

Discards: High grading and discarding, where less valuable species (or sizes) of fish caught are thrown back into the sea, dead or alive, are key issues associated with ineffective ITQ management of fisheries. The goal of fishers is to ensure their quotas are filled with the most valuable fish available. The incentive to discard or high-grade can be substantial under ITQ schemes; for example high grading is an issue in the Greenland shrimp fishery because of inadequate monitoring and enforcement. The extra cost of monitoring and enforcement to prevent high grading and discarding may undermine the efficiency benefits that ITQs are supposed to create.

Inequity: The concentration of fishing power has been noticed in many fisheries in which ITQ schemes have been introduced. This should not be a problem and proponents of ITQs expect concentration to take place, often with fleet reduction being one of the channels through which economic efficiency is achieved following the introduction of ITQs. In theory, more efficient fishers buy out their less efficient counterparts, and in so doing increase the overall returns to the fishery. However, quotas for particular stocks may concentrate in the hands of a few larger more business-oriented fishing companies (as has happened in New Zealand) and the problems associated with this have attracted a lot of discussion and debate. Some of the main concerns include, (1) fear of monopoly power developing in a fishery, (2) the potential for increased social inequity, (3) the potential for more effective lobbying by the larger operators swaying management decisions and (4) pressure to delay or defer the introduction of environmentally responsible fishing requirements or practices.

BOX 18 cont

These concerns are not always valid. In some fisheries, the larger companies have led efforts to achieve environmental best practice, because their large capital investments in fleet infrastructure can be a powerful incentive to ensure the fishery and its associated ecosystem remains viable in the longer term. The New Zealand Hoki fishery is an ITQ based fishery with 80% of the quota held by six large fishing companies. This fishery, which achieved Marine Stewardship Council certification in 2001, reduced the Hoki TAC for 2002 to ensure the long-term viability of the stock. While the fishery is required to make some major corrections to maintain MSC certification, the price of Hoki in the European Union has now increased and is compensating for the recent TAC reduction.

Ecosystem impacts: the allocation of an ITQ has the potential to recognise ecosystem constraints, such as when determining the level of TACs. However, without specific ecosystem protection measures also in place, such as mosaics of no-take reserves, an ITQ will not achieve ecosystem protection beyond target stock management. The current design of stock assessment regimes used to determine TACs does not consider the ecological associations of the target stock discussed in Box 17 and Section 4. Additional environmental controls must therefore be linked with ITQs, but this approach (parallel input controls) has not been broadly adopted and implemented. Therefore the rights holder of an ITQ is not usually sufficiently responsible for managing ecosystem impacts associated with the ITQs.

However, it is being increasingly recognised by some fishery management agencies that ITQs are only one of a suite of tools required to manage fisheries and their interactions with marine ecosystems. The Ministry of Fisheries in New Zealand, responsible for much of the promotion and leadership of ITQs in the 1990s, acknowledges that ITQs alone are insufficient for managing any aspect of a fishery other than the target stock:

> 'Although catch-limits can be successfully employed to ensure sustainable harvests of commercially sought species—in most cases further controls will be necessary to ensure the sustainability of future harvests.
> They may include:
> i. gear restrictions to reduce environmental degradation
> ii. mechanisms to minimise incidental catch of non-target species…
> iii. mechanisms to ensure sustainability of catch for stocks not in the quota system and
> iv. protection of juvenile fish and spawning and nursery areas.
>
> These issues need to be considered prior to allocation of quota and the establishment of management areas. For example, closures or reserves may be useful mechanisms to address some of these issues…' (Edwards 1999).

Experiences
The implementation of ITQs in the Netherlands in 1976 did not prevent a fall in the biomass of the plaice stock (Salz 1996). This is because ITQs are not an instrument for stock conservation (Hannesson 1996).

ITQs could negate conservation effort, contrary to the economic theory predictions through:

1. concentrating quota in the hands of only a particular type of vessel group leading to biological losses that are followed by economic losses – particularly if the vessels target only a certain age group of fish (Armstrong & Sumaila 2001);
2. promoting thinking in government that users are now wealthy and capable of paying for all aspects of resource management. However, industry only may be willing to pay for stock management. Governments may then abandon any ecosystem related management costs, if industry is unwilling to pay;
3. technology creep: contrary to the theory of ITQs, because of the increased wealth they can stimulate, ITQs tend to encourage increases in fishing power. An ITQ regime can put 'new' capital into fisheries and therefore fishers feel obliged to increase capacity to catch their quota more quickly;
4. industry arguing that input controls are no longer needed given the right 'escapement' factor. Arguments are often against area or temporal closures, which are perceived to reduce the ability to take the full quota even when such action may be warranted to save the fish;
5. reliability of data decreasing because ITQs encourage quota busting i.e. fishers under-report landings to catch more fish than their quota allows.

BOX 18 cont

While some of these problems do not afflict all ITQ schemes, they undermine the benefits ascribed to them. Often, short-term benefits from actions such as high-grading and mis-reporting quota will accrue to the individual fisher, while long-term costs are spread over all participants, and so true property rights are not created by ITQ systems.

Improvements/Alternatives to ITQs

New Zealand and other countries have introduced rules to limit concentration in their ITQ managed fisheries. In Namibia, despite the large volume and single-species nature of their fisheries, which might make the ITQ approach attractive, fisheries managers have shunned ITQ management for social reasons due to the legacy of apartheid. Siegel (2000) argues that rather than using ITQs, the USA should maintain the basic structure of the current fisheries planning regime, and modify it according to the habitat conservation program (HCP) model. This combination could work toward alleviating overfishing. Some authors argue that rather than allocating transferable quotas to individuals, they should be allocated to communities as *community transferable quotas* (CTQs) and to residents of a territory as *territorial use rights in fisheries* (TURFS). This would minimise their social impacts.

As ITQs are not designed to ensure conservation (Hannesson 1996), it is important for managers to supplement ITQ schemes. This can be achieved with all the tools available to ensure resource and ecosystem conservation: pursuing more reliable stock assessment; marine protected areas; management of essential habitat, safe minimum biomass levels, gear restrictions in certain habitats, and other input controls.

The need to support the use of ITQ schemes with a more precautionary approach to conservation has led some fisheries scientists to propose the concept of *ecological or environmental quota.* This is the idea of allocating a quota to the ecosystem first before indigenous, commercial, or recreational quotas are determined. This idea is not as revolutionary as it may seem. It is another way of expressing the safe minimum biomass level concept – where management stipulates the level of biomass of each species to be maintained in the ecosystem. All other allocations of biomass (as catch) to the various sectors of a fishery are then made only after the ecosystem goal has been attained.

Prepared with contributions from: Ussif Rashid Sumaila and Reg Watson (University of British Columbia Fisheries Center, Canada).

3.5 Management Systems

Modern natural resource management systems use the principles of outcome-oriented, objective-based management, and use management plans, strategies and actions designed to ensure the intended outcomes are attained in the desired way. The management plan identifies the boundaries of the management system, the beneficiaries, the resource base, and the inputs to, and outputs from management. It is the pivotal feature in objective-based management. The process of preparing a plan of management is also central to ensuring stakeholders have a common and agreed understanding of the issues. They must be a party to the plan, its development and its implementation.

BOX 19

STAKEHOLDER INVOLVEMENT IN FISHERIES MANAGEMENT PLANS

If properly designed and implemented, fishery management plans (1) enable an integrated approach to fishery management; (2) take ecosystem effects into account, and (3) mitigate the impacts on or protect significant habitats, non-target fish species, and associated and dependent species such as marine mammals and sea birds. Fishing need not be detrimental to the ecosystem if a plan contains measures to restrain effects to acceptable, defined and agreed levels. Management plans for fisheries using an Ecosystem-Based Management system also ensure that the concerns of all stakeholders and any legal obligations (national and international) are addressed.

To ensure that stakeholders are properly engaged with the planning and management process, good Fisheries Management Plans (FMPs) need to be based around the following principles.

Stakeholder participation

The process of designing an FMP needs to be as inclusive as possible of stakeholders, including indigenous people, with effective procedures for seeking their input. A strategy for defining any problems through identifying and working through the perspectives of different stakeholders will help to clarify collective objectives for the fishery. An effective dispute resolution mechanism needs to be available for issues that cannot be resolved through a consensus-based consultation process.

Vision

Stakeholders contribute to a vision for fishery management, helping to explore where the fishery could be in five or ten years time, and considering the trade-offs that the wider community may be prepared to make to achieve that end.

Transparency

The FMP should be readily available to the public and contain clear and explicit rules and procedures (that may include traditional and customary practices). The plan needs to be easily understood by all stakeholders, and apply to all sectors harvesting the resource including the recreational sector. Periodic external review of the management system and its performance by independent peer reviewers is essential to maintain rigour. Compliance and enforcement strategies and monitoring and performance evaluation procedures also need to be outlined, made accessible, and communicated clearly to all stakeholders.

Clear process

Vital to the success of the FMP are clear strategies and procedures for implementing the plan and for ongoing monitoring and regular performance evaluation. This includes a harvest strategy, short and long-term sustainability objectives, operational criteria and performance measures for those objectives, and procedures for monitoring the performance measures. Strategies should be in place to address significant environmental impacts of fishing, and a clear process for accountability on any environmental issues.

Harvesting strategies should consider the potential detrimental impact on other species or the environment where the fishery operates. Periodic reviews will enable harvesting rates to be assessed and adjusted as necessary, using robust assessment methods that consider the use of a range of management tools, including a monitoring program for each species targeted. A clear and explicit process for allocating the fisheries resource also is required, along with effective processes to manage and control harvesting activities in the fishery according to the harvest strategy.

Conceptual models linking the resource to the biodiversity and ecosystems where the fishery operates should be clear and transparent to stakeholders and include all aspects of the harvest strategy demonstrating how the management process works in accord with the management plan.

Prepared with contributions from: Jo Anderson – WWF NZ

BOX 20

SEANET ... SMARTER FISHING FOR INDUSTRY

The SeaNet project was established in 1999 to facilitate progress in implementing sustainable fishing practices by working closely with the Australian commercial fishing industry. Its primary objective is to provide easy access to information and advice about bycatch reduction and environmental best practice. SeaNet is based on:

- face-to-face communication
- hosting extension officers in industry association offices
- establishing partnerships with researchers
- encouraging networking with research providers, industry groups, environmental groups and other interested parties.

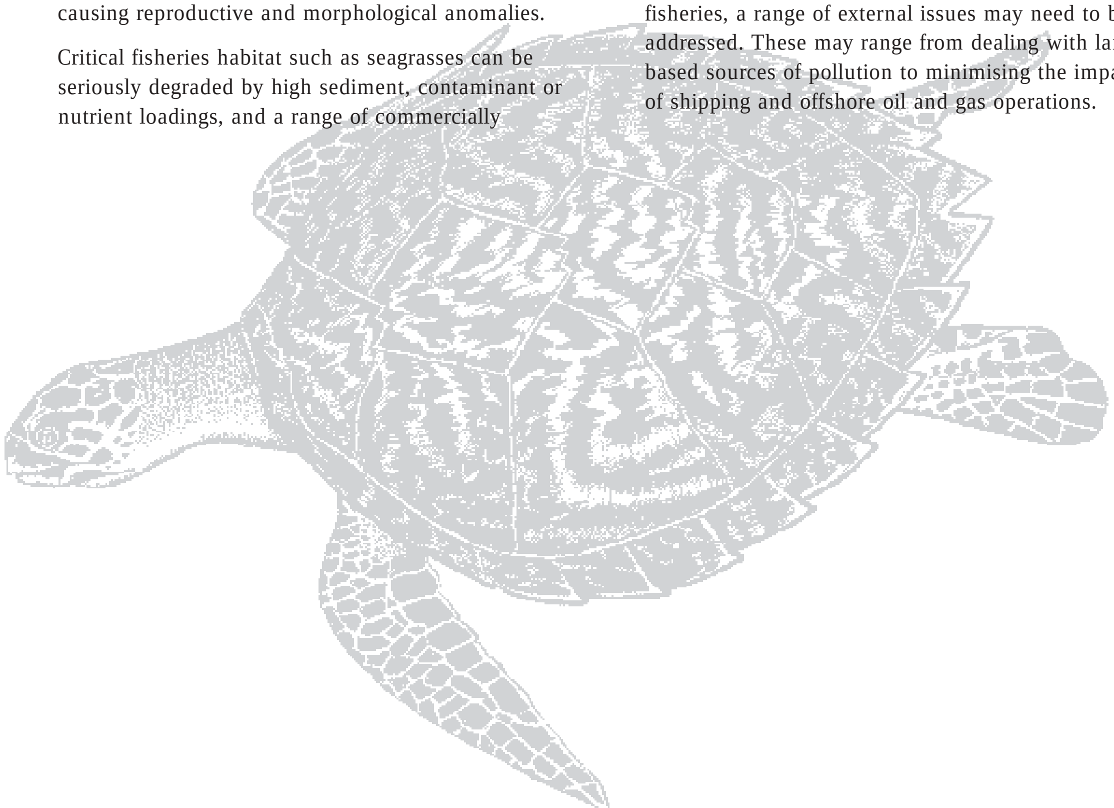
This approach has resulted in commercial fishers around Australia voluntarily working with SeaNet to trial bycatch reduction devices and techniques such as acoustic alarms ('pingers'), swim tanks ('hoppers'), square mesh panels, Nordmore turtle excluder grids, and polyethylene haul seine nets. SeaNet also assists commercial fishers and fisheries to prepare and implement Environmental Management Plans, Codes of Conduct and Environmental Action Plans.

SeaNet is operated by Ocean Watch Australia Ltd, and receives funding from the Australian Government's Natural Heritage Trust and from industry. It is overseen by a steering committee with representatives from the commercial fishing industry, government, research institutions and the Australian Marine Conservation Society.

3.6 Externalities

The high levels of interconnectivity of marine ecosystems make them vulnerable to impacts resulting from activities at distant sites. Contaminants entering aquatic systems can be quickly assimilated but also very quickly dispersed. This can result in widespread contamination that may be difficult to detect or monitor and which can accumulate in marine species over time, causing reproductive and morphological anomalies.

Critical fisheries habitat such as seagrasses can be seriously degraded by high sediment, contaminant or nutrient loadings, and a range of commercially important species, particularly shellfish, can suffer serious contamination by toxic compounds. Fishing grounds are often close to areas coveted for tourism, ports or other coastal uses, and can overlap with areas highly prospective for offshore oil and gas resources, as well as routes for coastal or international shipping. Consequently, in implementing EBM for marine capture fisheries, a range of external issues may need to be addressed. These may range from dealing with land-based sources of pollution to minimising the impacts of shipping and offshore oil and gas operations.



BOX 21

LAND-BASED SOURCES OF POLLUTION

The impacts of land-based sources of pollution on the marine environment are well recognised and well documented. In the Great Barrier Reef World Heritage Area, water quality targets are being proposed to manage sources of land-based pollution, consistent with an EBM approach.

Great Barrier Reef Water Quality Action Plan
Decades of scientific research and evaluation have clearly established that land use activities in river catchments adjacent to the Great Barrier Reef are directly contributing to a decline in water quality. A range of pollutants in river outflows is degrading the inshore ecosystems of the Reef. Similar patterns of pollutant-related decline have led to the collapse of coral reef systems in other parts of the world.

Increases in pollutants discharged to the Reef since circa 1850 are as follows:

- sediment loads – up between 300 and 900%
- phosphorus – up between 300 and 1500%
- nitrogen – up between 200 and 400%
- pesticide residues – now detectable in coastal sediments.

Monitoring is showing that almost all pollutant loads are increasing annually with no sign of abatement. The rapid increase in nitrogen compounds (derived from fertiliser) and herbicide residues that damage seagrass and, potentially, coral communities, is an issue for coastal marine ecosystems and fisheries that needs urgent attention.

Pollutants from the twenty-six individual Great Barrier Reef catchments vary significantly, due to the volume of runoff from the catchments, and the nature of the land uses. Virtually all of the developed Great Barrier Reef catchments have serious concentrations of water-borne pollutants. These pollutants seriously impact on the health and reproductive capacity of corals, seagrass and fauna of inshore reef areas.

In response to the directive of the 8 June 2001 Great Barrier Reef Ministerial Council, a scientific working group was established to review available data on pollutant runoff and existing national water quality guidelines, to prioritise catchments according to the ecological risk to the Reef, and to recommend the minimum targets for pollutant loads to halt the decline in the quality of water entering the Reef.

This is the first phase in a staged approach that aims to stop the decline of water quality and eventually allow for the recovery of inshore reef ecosystems.

The working group has defined 10-year targets (2011) for the entire Great Barrier Reef catchment, with individual catchment targets. The overall targets are:

- sediment – a 38% reduction from 11,700,000 tonnes per year to 7,300,000 tonnes per year
- nitrogen – a 39% reduction from 39,300 tonnes per year to 24,000 tonnes per year
- phosphorus – a 47% reduction from 7,400 tonnes per year to 3,900 tonnes per year
- chlorophyll – a 30–60% reduction below present levels in coastal waters
- heavy metals and pesticides – reductions in detectable levels.

The targets allow for the natural variability in runoff to the Great Barrier Reef, and permit meaningful comparison between years.

The water quality targets for the Great Barrier Reef will be delivered within a framework that ensures strategic federal input but with the responsibility for on-ground implementation devolved to the appropriate level.

Source: Great Barrier Reef Water Quality Action Plan, Great Barrier Reef Marine Park Authority.
Full report available at: ***www.gbrmpa.gov.au***

BOX 22

SHIPPING

Shipping is an international activity regulated by the International Maritime Organization (IMO). Within territorial waters up to 12 nautical miles offshore, coastal nations can impose national controls on shipping activity provided they do not prevent ships from entering these waters or prevent access to ports and harbours. Beyond 12 nautical miles any regulation of shipping has to be through the IMO.

Shipping activity can affect the marine environment and commercial fish stocks in a number of ways, including:

- accidental spills of oils or chemicals
- operational discharges of oils, chemicals, sewage, garbage and air emissions
- chemicals used as antifouling paints
- introduction of alien species from the surface of hulls or in ship's ballast waters.

Oil and chemical spills can cause severe habitat contamination that may last for many years. Following the *Braer* spill in the Shetland Islands in 1993 shellfish fisheries were closed for seven years. However, the largest volume of oil from shipping comes from the routine discharge of tank washings and bilge water. While operational discharges are still legal in many parts of the world, the concentration of oil is frequently higher than permitted under international regulation.

It has recently been discovered that hydrocarbon toxicity in the presence of UV light is increased a hundredfold. In the marine environment, UV light and hydrocarbons are most likely to interact in the surface waters where eggs and larvae of many commercial fish spend the first part of their life cycle. It is not yet known how this affects the survival and viability of fish eggs and larvae or the populations of utilised species.

The recognition that organotin chemicals in antifouling paints have also contaminated the marine food chain including commercial fish has led to renewed action within the IMO to ban the use of these chemicals.

Introduction of alien species via hulls and ballast water is another serious threat to marine ecosystems and associated fisheries. In USA, Canada, Australia, New Zealand and other countries, introduced marine pests have serious impacts on a range of different fishery types, and management and restoration costs are high. Mitigation measures are only partly effective and research programs are now underway to develop on-board systems of filtering and sterilising ship ballast waters.

In delivering an ecosystem approach, it is important to consider all demands made on the marine system in question, including the passage of shipping. Under international law, shipping has freedom of navigation, which might appear difficult to influence. However, strategic environmental assessment can be used to assess the nature of shipping activity within a region, and risk analysis applied to identify 'high risk' areas. Improved navigational aids and charting, differential GPS stations for highly accurate position fixing, ship position reporting systems, compulsory pilotage, and one-way traffic shipping lanes are all measures that can be employed to substantially reduce risks of shipping accidents in highly sensitive areas.

Provided we avoid contravening international shipping legislation and do not compromise shipping safety, it is likely that the international shipping community will comply with good Ecosystem-Based Management recommendations. In cases where the waters are shallow and contain many shoals and reefs and the environmental values are high, the IMO may designate Particularly Sensitive Areas that shipping should avoid and a program has commenced to identify these areas.

Because of the relatively low recovery of spilled oil and the extensive environmental damage from large oil spills, the emphasis should be on preventing shipping accidents. However, even spills of a few hundred tonnes can be very damaging if they affect sensitive sites, such as shellfish beds or bird rookeries, so a spill response capacity also is needed. This should include stockpiling oil spill combat equipment in strategic locations, training personnel in rapid deployment, and having agreed lines of command and an emergency communications system that are triggered in the event of an accident.

Prepared with contributions from: Sian Pullen (WWF UK).

BOX 23

OIL AND GAS

Traditionally, offshore oil and gas development has largely been undertaken in shallow, continental seas although in recent years there have been moves to exploit reserves further offshore and in deeper water. Currently there is no global regulation of offshore oil and gas development, although some regional seas agreements provide a management framework for development at a regional level. Where there is no such agreement, the management of the offshore oil and gas industry is frequently left solely to the coastal nation in whose waters the oil or gas reserves are present. Often, the process is managed by a government department with little responsibility for environmental matters and often with a mandate to assist the development of such reserves.

Rarely are stringent controls put in place or the most up-to-date techniques used. Indeed, in one of the most comprehensively managed seas of the world, the North Sea, the volume of formation water and entrained hydrocarbon residues discharged into the marine environment is increasing.

The impact of offshore oil and gas development on marine ecosystems and fisheries varies according to the stage and scale of development, including:

- seismic activity, which can result in fish deaths and/or disturbance to fish stocks
- discharges of cuttings, which can smother important habitats
- discharges of oils, muds, chemicals and production water, which can contaminate the food chain
- accidental spills of oil and chemicals, which can have long-term impacts on sensitive fish habitats as well as direct impacts on fish and fish stocks
- congregation of marine life around the sub-surface portions of the oil platform, which acts as a form of artificial reef.

The discharge of oils and chemicals from offshore development contaminates food chains, including commercial fish species. In some regional seas, improvements have been made in the use and discharge of toxic chemicals and oils, but this is not always the case. Whilst considerable improvements have been made in the treatment and disposal of produced water and drilling muds, the high volume of these wastes is still cause for concern, even if contaminants are present in low concentrations.

The main environmental concern with offshore oilfield development is the low risk of a catastrophic blowout accident. Some offshore blowouts have taken weeks or even months to cap and have released very large amounts of oil before the well could be brought under control. Oil slicks have contaminated shorelines more than a thousand kilometres from a blowout site. Technological improvement over the last two decades has not succeeded in overcoming the problem of human error, and drilling is now taking place in much deeper water. A related risk is that the shipping traffic associated with offshore oilfields may lead to increased probability of collisions with reefs or other ships and result in a major pollution incident.

An EBM planning framework may assist the fishing industry in ensuring, at least, that pipelines and loading facilities are not sited on fishing grounds, crucial fishery nursery areas or spawning grounds, and that transportation corridors are designed to minimise the potential impacts on fishing. However, the risks associated with oil and gas exploration and production are generally considered too high for SEA or EBM protocols to be considered adequate to protect marine protected areas that are managed under the IUCN Categories I or II[7] (the most highly protected reserves). Oil and gas activities would not be consistent with no-take reserves established by a fishery to assist with, for example, protection of a stock against overfishing.

[7] **http://wcpa.iucn.org/pubs/pdfs/IUCNCategories.pdf**

Prepared with contributions from: Sian Pullen (WWF UK) and Simon Cripps (WWF International).

IMPLEMENTATION OF EBM

Implementation of EBM involves a wide range of possible actions and activities that might be undertaken in a fishery, with the attendant costs and benefits. However, when building on an existing management system, it can be difficult to identify the *key actions* that must be implemented first to achieve the desired EBM objectives and outcomes. This requires a predictive capacity to explore how the benefits of specific EBM outcomes can be traded-off against any costs. It is also important to identify the vertical linkages between policies, strategies and plans and local activities that operate in a fishery. Finally, those designing policy frameworks need to ensure an incentive structure operates in favour of appropriate strategies and activities.

4.1 An Hypothetical Example

The following hypothetical example[8] (Table 6) is provided to indicate how a coastal fishery might implement Ecosystem-Based Management. It assumes the fishery has in place an adequate stock management system, avoids overfishing of the single species being harvested and considers ecological relationships, and that the management system is high quality and conforms broadly to international standards of 'best practice' for stock management. This may not always be the case, so where a stock management system is inadequate, the implementation of Ecosystem-Based Management needs to be more expansive than described below. This will be particularly true when stocks are being overfished.

This example is aimed at clarifying how to implement Ecosystem-Based Management with respect to the *effects of fishing* on the ecosystem. Stock issues are included, but the stock assessment is not the main focus of this example. In general, the technical issues and stock assessment procedures for avoiding overfishing are well understood, even if not always fully agreed. Often the issues surrounding overfishing of a stock are socio-economic (for example issues of over-capacity) rather than scientific, and these need to be addressed using a process of comprehensive stakeholder involvement.

In a real fishery, the EBM process for considering and managing impacts on ecosystems would be integrated and run simultaneously with the stock assessment process. It is important to ensure that the stock assessment includes as many of the ecological relationships of the target species as possible, including evaluating the impacts of the various harvest strategies on associated species.

For EBM to be effective, the requirements for achieving ecosystem objectives must be translated into actions to be delivered within the controls available to fisheries managers (the 'levers' that a fishery manager can use). The fishery management system has only a limited number of 'levers' it can exercise including, for example, controls on catch, effort and locations where fishing can occur, depending on the nature of the management system in place.

[8] This information has been compiled from a range of recent publications; see the References for a complete list.

Table 6. Guidelines for implementing Ecosystem-Based Management in a hypothetical coastal fishery

COMPONENT	INVOLVING	INTENDED OUTCOMES
1. Identify stakeholder community.	• Fishery management agencies, conservation agencies, conservation NGOs, local community groups, scientific/academic research community, fisher associations or cooperatives, higher and lower levels of government, fish processing / distribution groups, indigenous representatives.	• A formal network of interested parties with whom the fishery representatives will participate to prepare and review the management of the fishery. • A transparent and fully accountable process enabling the participation of all interested parties in the process of managing the fishery.
2. Prepare a map of ecoregions and habitats.	• Conducted by the fishers, research community, fishery managers, stakeholders and partners. • Covers the full area of fishery operations. • The focus is on areas where the fish are, where they are fished, and any specific spawning, nursery or similar obligate habitats or locations. • High resolution is needed in benthic primary producer habitats (such as algal beds, seagrasses, mangroves, coral reefs).	• Maps of the ecosystems throughout the fishery at scales of resolution consistent with the scale of the fishery. • Resolved habitats at a scale consistent with the potential impacts of the fishery. • Coherent with other ecosystem classification nitiatives (at both larger and smaller scales). • Major features and exceptions documented (e.g. highly migratory species, oceanographic currents or features, boundary mismatches between taxa). • Major uncertainties identified and documented as guidance for research and investigation programs.
3. Identify partners and their interests / responsibilities.	• Conservation, environment protection, and coastal planning agencies from all levels of government. • Major users and managers of other, possibly co-located, resources (e.g. tourism, mining, oil/gas, transport, and communications). • Directly affected local communities.	• Clarify specific roles and responsibilities for management in the marine environment. • Engage with other supportive interests. • Promote the opportunity for coordination and integration, improved efficiency across government and better outcomes for marine management, better agency outcomes for lower cost, more accountability in government, more effective long-term solutions to marine ecological problems, and shared approaches to problems held in common.
4. Establish ecosystem values.	• Fishers, research community, fishery managers, stakeholders, partners and the public; designed to identify all major uses and all major natural and ecosystem values throughout the area where the fishery operates.	• A detailed distributional analysis of the main attributes of the ecosystem where the fishery operates. • A clear and agreed expression of the natural and use values, which could include: - highly valued habitats; - representative areas dedicated as reserves; - protected species feeding, breeding, or resting grounds; - fishing, spawning grounds, recruitment areas and migration paths for commercial species; - highly productive areas such as upwellings; - areas popular for recreational fishing or diving; - areas used for ports and harbours; - areas of high scenic and wilderness amenity; - high cultural and historic value; - traditional hunting grounds for Indigenous peoples; - areas of high tourism value; - areas used for dumping of dredge wastes, defence training etc.
5. Determine major factors influencing ecosystem values.	• Establishing cause-effect relationships; consider factors both internal and external to the fishery management system. • Conducted by the fishers, research community, fishery managers, stakeholders and partners.	• Identified hazards to marine ecosystems and their values from the full range of actual and potential human impacts that occur in the fishery region. These could include: - extent of loss/damage of marine habitats; - effects of specific fishing gear on benthic habitats; - effects of pollution from coastal rivers on inshore

Table 6. (continued)

COMPONENT	INVOLVING	INTENDED OUTCOMES
		habitats; - risk of marine pest invasion and disruption to critical habitat or fishing operations; - effects of the removal of the biomass of harvested species (in all fisheries) on trophically dependent species.
6. Conduct Ecological Risk Assessment (ERA).	• ERA conducted with participation of all stakeholders and partners, fishers, research community and the fishery manager: • uses broad multi-disciplinary knowledge base; • identifies key areas of uncertainty; • open for public scrutiny and review; • fully peer reviewed by independent authorities.	• Agreed estimates of high, medium and low risks of the fishery to the ecosystem values identified in step 5, such as the risk of the fishery to protected species, and to the ecosystem, habitats, species and genetic diversity.
7. Establish objectives and targets.	• Fishers, research community, fishery managers, stakeholders and partners. • Performance objectives and targets established for: - high and medium priority risks from the ERA; - important aspects of the ecosystems (including protected species, critical habitat); - stocks.	• Agreed and shared goals for specific elements of ecosystems. • Specific performance objectives and targets for important elements of the ecosystem. • Objectives and targets that are comprehensive and precautionary in terms of valued aspects of the ecosystems. • Could include: - maintaining or recovering population sizes of protected species; - maintaining the distribution, area, species diversity and trophic structure of important habitats; - reducing fishing effort in specific areas to help protect populations of benthic fauna; - increasing the distribution and diversity of benthic fauna considered to be affected by fishing; - rehabilitating marine ecosystems to a past (healthier) condition.
8. Establish strategies for achieving targets.	• Fishers, research community, fishery managers, stakeholders and partners. • Focus is on identifying appropriate and workable strategies to achieve objectives and targets, and on specific capacity matched to responsibilities for implementing strategies. • Strategies designed based on best understanding of the cause-effect relationships developed in Step 5, and matched to highest priority needs for corrective actions identified in Step 6 (ERA). • Use of incremental strategies where necessary and unavoidable.	• Series of prioritised strategies that define workable activities and responses to achieve specific objectives and targets identified in Step 7. Includes who is responsible, what funds and time frames are involved, what controls are needed and where data/outcomes are reported and assessed. • Strategies could include: - declaring a network of sanctuary protected zones; - establishing buffer zones where only specific uses, or types of fishing, are permitted - research on improving gear design to reduce impacts on a sensitive habitat, or reduce the bycatch of an important species; - improved fishery-independent monitoring of catch, or bycatch; - reducing pollution from coastal rivers; - constructing fish escapement panels in trawl nets to avoid catch of a certain type and size of fish, or to reduce overall fish bycatch; - implementing an industry code of practice to reduce risks of bait discards to bird populations.
9. Design information system, including monitoring.	• Fishers, research community, fishery managers, stakeholders and partners. • Focus is on capture of appropriate data/information	• Efficient and effective fishery information system that provides data and information on stock and ecosystem performance (additional to information

Table 6. (continued)

COMPONENT	INVOLVING	INTENDED OUTCOMES
	to determine if : strategies are working as expected; objectives and targets are being achieved; cause-effect models are correct; fishery impacts are being reduced. • Collaboration and contributions from partners identified.	needed for stock management); identifies specific effects of fishery strategies on ecosystem values. Could include: - Periodic mapping of important habitat distributions; - Population census of important protected species; - Species diversity in fished habitats; - Distribution of fishing effort by gear types and fine spatial scale; - Size/age classes in harvested species; - Species diversity in closed areas.
10. Establish research and information needs and priorities.	• Fishers, research community, fishery managers, stakeholders and partners. • Focus is on identifying specific high priority areas of uncertainty, and on quality science outcomes, for both stock and ecosystem issues. • Collaboration and contributions from partners identified. • Research strategies are fully peer reviewed or independently audited.	• Comprehensive research programs targeted at resolving key ecosystem and stock issues in the fishery. Could include: - habitat mapping; - impact of fishing on specific habitat types; - effects of coastal development on recruitment of harvested species; - design of monitoring programs to resolve important changes in habitats; - biological data of key species (both utilised and non-utilised); - determining the dietary preferences of harvested species and their major predators; - species composition of bycatch with different gear types used in the fishery.
11. Design performance assessment and review processes.	• Fishers, research community, fishery managers, stakeholders and partners. • Focus is on a process that is participatory and inclusive. • The locations, timing and resourcing enables partner and stakeholder participation in reviews of performance of the fishery in relation to stock and ecosystem values. • Performance outcomes peer reviewed by independent authorities.	• Periodic (but regular) forum for discussion, review and assessment of fishery performance by partners, stakeholders and the public. • Periodic (but regular) forum for review, assessment and revision of monitoring data, objectives and targets by stakeholders and partners.
12. Prepare education and training package for fishers.	• Fishers, fishery managers, extension experts and stakeholders and partners.	• Outreach program to provide training and support for fishers about new fishery management, ecosystem or other EBM initiatives, and provide local technical support for assessment and resolution of ecosystem issues; to commence at the time of Step 1.

4.2 Fishery Controls

In a fishery being managed according to the principles of EBM, the requirements for environment protection must be translated into mechanisms that are (typically) used to control catch and effort in the fishery. So, for example, in an input controlled fishery, the ecosystem requirements need to be translated into levels of effort that achieve the objectives for the relevant ecosystem components. This might, for example, mean developing a network of closed areas where fishing is not permitted. If properly designed and implemented with the support of the fishers, the closed area network could help to achieve ecosystem targets.

In an output controlled fishery, catch limits may be imposed by size or age class of the harvested species with similar controls for any associated species. This can reduce the pressure on the stock and simultaneously retain a more natural size range (the ‘size spectrum’) in the population of the target species, thus benefiting species that may be dependent on the harvested species for prey.

The two types of control requirements (for ecosystem management and stock management), once translated into the same 'currency', i.e. the control options available to fishery managers, should be brought together through periodic stock review and ecologically-based assessment, ideally conducted annually. Here both sets of requirements can be considered and future catch limits, i.e. Total Allowable Catch, defined and implemented within the management system.

There is as yet, no formal standard mechanism for combining ecosystem and stock requirements into fishery controls for an EBM system. In principle, greater accuracy in predicting outcomes of management scenarios for TACs should be possible with the increasing sophistication of ecological modelling (Cury et al. 2001), and improved stock assessment and evaluation of management strategies such as Management Strategy Evaluation described in Box 6. But establishing the specific effects of fishing on non-target species, remains an impediment to substantive progress. At present managers are limited in their understanding and ability to convert meaningful ecosystem objectives into specific, operational or measurable fishery controls. The present-day processes for achieving this in fisheries management for single-species stocks need to be substantially developed and further defined.

4.2.1 Ecologically-Based Decision Rules

Although at present there is only a limited use of ecologically-based controls and decision rules in fisheries, such concepts are similar to those used for stock management. The introduction of what might be termed ‘ecosystem constraints’, ‘ecosystem quota’, ‘ecosystem allocation’, or just a more highly conservative safe biomass level for harvested species to take account of ecosystem requirements and stakeholder concerns, are new concepts. However, they are likely to be easy for fishery managers to incorporate into existing management systems provided they can be evaluated and expressed in the units of common currency for fishery control (such as a TAC). The approach for deriving the ‘ecosystem allocation’ is new and is based on the analysis of ecosystem impacts of fisheries. This is where many fishery managers find the notion of EBM most difficult to design and implement, and where most resistance occurs in accepting and implementing the concept of EBM within management in government and industry.

Managing fisheries to maintain target levels of biomass estimated to be between 20 and 40% of virgin biomass may produce, with some stocks, optimal production of new recruits and high yields and be perceived as a highly productive and well-managed fishery. Yet often, the question of what has changed in the ecosystem as a result of the continuing harvest of 60 to 80% of the original biomass in TAC controlled fisheries, remains unanswered.

EBM is the framework through which these questions, necessary for the long-term ecological health of target species specifically and marine ecosystems more generally, can be asked. Mechanisms to determine and understand the answers can then be developed, and corrective actions taken where necessary.

The processes of EBM enable stakeholders, particularly the partners (see below), to become closely engaged in planning processes. These include the setting of acceptable levels of the fishery’s impact on habitats, non-target and associated and dependent species; and the setting of targets for the fishery to achieve against these objectives, including situations where habitats and species have been degraded by fishing in the past. This enables partners to participate in establishing achievable targets for the fishery for restoration and rehabilitation of species and habitats adversely affected by fishing, and to evaluate the resource and financial trade-offs involved.

The example provided in Table 6 uses a set of steps, which could be implemented in a sequential manner (although this is not a requirement for success). However, the entire set of steps is closely interconnected so, if one or more is not in place, Ecosystem-Based Management will not be achieved.

In this example, a government agency is the manager of the fishery; a common situation. Also, broader stakeholders are considered to be separate from a small inner group of agencies, industry groups and NGOs who would be most intimately involved with the management of the fishery and the attendant ecological issues. This inner group of agencies, industry groups and NGOs are termed the partners to identify their higher standing in the context of assisting the fishery managers to achieve outcomes for ecosystems and a healthy and productive fishery. The concept of *partners*, although common, may not apply in all fishery management systems.

5 CRITICAL OBSTACLES TO ACHIEVING EBM AT THE INTERNATIONAL LEVEL

To achieve healthy and well-managed fisheries and marine ecosystems globally, Ecosystem-Based Management is required at the level of each managed fishery. Many fisheries fall within the scope of a single national jurisdiction; others are jointly managed by two neighbouring nations with the fisheries (usually coastal) falling wholly within their EEZs. However, the need for EBM goes well beyond the need for each jurisdiction to accept and implement EBM for its fisheries. At the international level, cross boundary issues that need to be addressed include:

- trans-boundary stocks
- high seas stocks
- agreed international management frameworks
- trans-boundary impacts of fishing
- action plans for priority habitats and species.

Each of these issues can be linked to matters of governance, i.e. the structure, functions, linkages and responsibilities of the people and institutions that manage control measures. It has been argued that governance and institutions are the key problems facing the restructuring of global fisheries to meet the demands of EBM (Garcia & de Leiva Moreno 2001, Sissenwine & Mace 2001), and this is consistent with the experiences in other sectors. This problem of designing and implementing an appropriate form of governance exists at all levels in fishery management systems, and is as acute at the international level as it is at the national or fishery levels of jurisdiction.

5.1 International Action Required

There are five key international arenas where action is urgently required to promote the development of broad-scale activities consistent with the international dimensions of EBM:

- Improve governance of marine ecosystems by global advocacy for EBM in fisheries in a range of international forums, key global protocols, and support for the international implementation of the relevant UN treaties and agreements. This must include developing the capacity to create legally enforceable high seas protected areas.
- Improve governance of marine ecosystems through integrating the efforts of regional bodies responsible for various components of managing global marine systems (e.g. fisheries, environment and geophysical regional bodies) with a view to identifying a specific focus for integrated action in EBM.
- Develop international controls for IUU fishing activities.
- Develop species-specific protocols for international implementation to respond to the terms of UNCLOS, CBD and other related treaties.
- Develop suitable EBM procedures for use by small-scale or under-resourced fisheries.

5.2 Access Agreements

Many countries use Access Agreements as tools to both permit and control the exploitation of their EEZs by distant water fishing fleets. These Agreements usually set out the basis by which vessels are permitted to fish within an EEZ, including, amongst many others, rules for where fishing can occur and the required catch reporting procedures. Without robust Access Agreements, fishing of migratory species, such as tuna, is difficult to manage, and achieving EBM of such fisheries is highly dependent on the performance of the large, often dominant, distant water fleets.

BOX 24

ACCESS AGREEMENTS FOR DISTANT WATER FISHING FLEETS

Converting Policy into Action to Implement Ecosystem-Based Management

The 1982 Convention on Law of the Sea (UNCLOS) provided coastal nations with the right to declare and enforce a 200 nautical mile (nm) zone, within which each signatory nation also controls fisheries resources. With the rights to control came the responsibility to manage those resources in an environmentally and ecologically sustainable manner. After the declaration of their 200 nm Exclusive Economic Zone (EEZ), coastal nations realised that vessels from other countries were increasingly fishing the waters of their EEZ, often originating far distant from their own shores. Before the ratification of UNCLOS, the vessels of these foreign countries (distant water fishing fleets) often had little contact with the nation in whose EEZ they fished. And further, these fleets often fish in a manner different from those of fishers of the coastal nation, with very different standards of fishing practice applied by distant water fleets even though potentially operating alongside national fleets.

In addition to these largely economic, political and logistical problems, the utilised species being targeted by the distant water fleets are often migratory species (such as tunas). Without comprehensive regional (as opposed to national) stock management agreements, nations licensing distant water fleets to operate within their EEZs had little incentive to insist on sustainable fishing measures for regional stock protection. Such regional agreements are in place for some species, and are being developed for others, but nonetheless, the expression of these agreements as operational controls on fishing fleets (both domestic and distant water) is a matter of considerable uncertainty, technically, socio-economically and politically.

In some regions of the world, such as West Africa and the South Pacific, fishing by distant water fleets under bilateral access agreements now accounts for the vast majority of the fishing within national EEZs. However, historically, these bilateral access agreements have not ensured sustainable fisheries. Without a comprehensive mechanism linking global and regional policies and strategies to local actions in a fishing fleet, or to actions of individual fishers, initiatives such as access agreements designed to ensure the Ecosystem-Based Management and sustainability of fisheries will fail.

In order to address these problems, coastal nations have become signatories to a further UNCLOS-related measure: the Agreement for the Implementation of the Provisions 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 (UNFSA). The Agreement entered into force on 11 December 2001. It prescribes the mechanisms for international cooperation between coastal states and states fishing on the high seas to achieve long-term sustainability of highly migratory fisheries resources and stocks that straddle both high seas and EEZs. It also establishes minimum management standards applicable not only to fishing for straddling and highly migratory stocks on the high seas, but also to fishing for all fish stocks under the jurisdiction of the coastal nation concerned. The standards thus established by such international agreements should be reflected in any domestic arrangements as well as any bilateral access agreement to fisheries resources in a host nation's EEZ.

In response to this situation, WWF developed a Handbook (Martin et al. 2001) for use by nations wishing to enter into access agreements for the exploitation of their national fisheries resources by distant water fishing nations (DWFNs). The Handbook provides model access agreements, established legal norms, and a set of guiding principles for negotiating such agreements. The intention of this is to provide clear guidance about how to implement the standards of the UNFSA and related global standards at the operational level, leading to a consistent approach by nations to ensure the sustainability of fish stocks.

BOX 24 cont

The WWF handbook provides nine guiding principles for access agreements:

1. The total catch permitted to a distant water fleet as well as the total fishing capacity of that fleet under an access agreement should be consistent with a sustainable level of fishing, based on a clear scientific assessment of the state of stocks.
2. Arrangements for access should ensure that the distant water fleet assumes its proportionate share of the environmental costs of sustainable fishing in the fisheries for which access has been granted.
3. The interests of small-scale, artisanal fishers of the coastal state should be protected.
4. The flag state should take such action as may be necessary to ensure its flag vessels comply with the fisheries laws and regulations of the coastal state, including prosecution and appropriate punishment under its own domestic laws for serious violations.
5. The distant water fleet should cooperate with the coastal state in carrying out scientific research on the status of stocks and should undertake to collect and report in an accurate and timely manner data on catch and effort.
6. The coastal state should ensure, directly or through third parties, that its monitoring, control and surveillance capabilities are adequate to enforce its fisheries laws and regulations.
7. The terms and conditions for fishing under access arrangements should be based on best fisheries management practices.
8. The negotiation of and terms and conditions of access agreements should be transparent.
9. Before an access agreement is renewed, the parties should conduct a thorough review of the status of the fishery resources concerned. (from Martin et al. 2001).

These principles, and the model agreements in the Handbook, offer a coordinated approach to implementing specific elements of an Ecosystem-Based Management approach to migratory fisheries for species such as tunas and billfish and to species that straddle EEZs, such as orange roughy.

5.3 Fishing Capacity

Within the context of effective EBM, and in relation to both national and international waters, it is critical that plans of action to reduce capacity are developed and that fishing fleets are managed in accordance with the principles of EBM.

BOX 25

EXCESSIVE FISHING CAPACITY ON THE WORLD'S OCEANS

For centuries, fishers have travelled to remote waters to pursue their livelihood in uncontrolled waters. The establishment of Exclusive Economic Zones under the UN Law of the Sea created a situation where many of the vessels fishing these waters became displaced, wandering the seas in search of further catch. 'Distant water vessels have had to scramble for access to rich coastal waters or take their chances on the increasingly over-capitalised high-seas'[9].

Optimal (fishing) capacity according to the FAO is defined as:

> The desired stock of inputs that will produce a desired level of outputs (e.g., a set of target fishing mortality rates for the species being harvested) and will best achieve the objectives of a fishery management plan (e.g., minimising costs). Current optimal capacity may differ from long run optimal capacity, particularly if the fishery resource is currently depleted and the management strategy is to rebuild this depleted resource.

Overcapacity is: *'Capacity in excess of the optimal level'[10].'*

If there are too 'many boats chasing too few fish', a situation of over-capacity and overfishing inevitably ensues. The vessels are often supported through a range of incentives that keep them economically viable, and that without such support would prevent them from operating. It is estimated the value of these subsidies equates to between 20 and 25% of the value of the global catch. In the aggregate, worldwide fishing capacity has been estimated at up to 250% of the level needed to achieve sustainable fishing levels.

WWF's best 'guesstimate' is that the level of fishing subsidies totals US$15 billion[11]. The fleets they support often range far beyond coastal or national waters, fishing on the high seas, and through various agreements, in the EEZs of other countries (termed Distant Water Fishing Nations). The incentives are usually maintained by nations or sectors to support the shipbuilding industry, to maintain coastal employment, processing capacity, access to resources etc. The issue of reducing fishing capacity is vexed because it requires restructuring the fishing industry as well as the associated industries.

The former USSR and Japan account for over half the world's DWFN fishing at 32% and 21% respectively[12]. Spain accounts for about 10%. Other DWFNs include the Republic of Korea (5%), the Russian Federation and Poland (4% each), Taiwan, Portugal, Germany and France (3% each), Ukraine (2%) and Norway, Romania, Cuba, Bulgaria and the US (1% each). These vessels range all over the world's oceans catching millions of tonnes of fish of many species. Through the international attention brought to this issue in the 1990s it is also clear that they are often operating illegally, and are responsible for the incidental mortality of other marine species and damage to the seabed. The species affected include seabirds, sharks and rays, marine turtles, cetaceans, and a range of other fish species.

A Telltale Report

In 1998, the European Court of Auditors made a rare attempt to audit subsidies aimed at reducing the European Community's fishing fleet. The report revealed numerous examples of widespread misuse and multiple administrative failings. Among the improper subsidies described in the report, some bordered on the absurd. For example, the report found that subsidies – sometimes in the millions – had been paid to support:

- fishing activities of vessels that had already sunk or had been inactive for a long time
- the removal of fishing capacity from EU waters after other subsidies helped create that capacity in the first place
- operating vessels that were not technically fit for the subsidised activity.

The report found repeated instances of subsidies paid to companies that had misrepresented important facts in their applications for support. It noted that EU monitoring mechanisms could not really track how much public support had been given to any particular boat. The Court found the government made no effort to recover misspent aid, and concluded that the subsidies program had failed to meet its intended purpose of reducing overall fishing activity[13].

[9] WWF International.(1998). The Footprint of Distant Water Fleets on World Fisheries.
[10] FAO. (1998). Technical Working Group On The Management Of Fishing Capacity, La Jolla.
[11] WWF. (2001). Hard Facts, Hidden Problems: A Review of Current Data on Fishing Subsidies. A WWF Technical Paper October 2001
[12] WWF International.(1998). The Footprint of Distant Water Fleets on World Fisheries.
[13] European Court of Auditors, Special Report No. 18/98 (available at **www.eca.eu.int/EN/reports_opinions.htm**) in WWF's 'Fishing in the Dark' Brochure

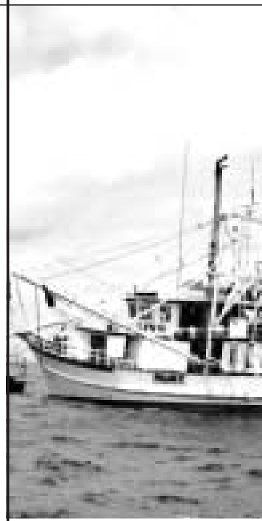
BOX 26

Paragraph 1 of the FAO International Plan of Action for the Management of Fishing Capacity (1999) states:

In the context of the Code of Conduct for Responsible Fisheries and its overall objective of sustainable fisheries, the issues of excess fishing capacity in world fisheries is an increasing concern. Excessive fishing capacity is a problem that, among others, contributes substantially to overfishing, the degradation of marine fisheries resources, the decline of food production potential, and significant economic waste.

Paragraph 7, Part II states:

The immediate objective of the International Plan of Action is for States and regional fisheries organizations, to achieve world-wide, preferably by 2003 but not later than 2005, an efficient, equitable and transparent management of fishing capacity. Inter alia, States and regional fisheries organizations confronted with an overcapacity problem, where capacity is undermining achievement of long-term sustainability outcomes, should endeavour initially to limit at present level and progressively reduce the fishing capacity applied to affected fisheries. Where long-term sustainability outcomes are being achieved, States and regional fisheries organizations nevertheless need to exercise caution to avoid growth in capacity undermining long-term sustainability objectives.



KEY DELIVERY MECHANISMS AND PROPOSED ENABLING ACTIVITIES

This section outlines nine *Delivery Mechanisms* and ten *Key Actions* that WWF is considering for cooperative development with appropriate stakeholders. It is intended that each Action will be designed and implemented in close consultation with stakeholders, including policy managers, scientists, fishery managers, fishers and their representatives, local non-government organisations, and the international donor and aid community. WWF believes the issues addressed in these Mechanisms and Actions are those most critically constraining the broad implementation of EBM in the world's fisheries. For each focal issue a high priority response (Delivery Mechanism and Key Action) is identified that would help to overcome key obstacles to progress.

Achieving a common understanding of the problems and needs, and developing a shared vision of how to ensure progress, is vital because of the highly complex nature of the issues surrounding EBM. No single stakeholder (including WWF) can expect to unilaterally derive a set of solutions that will achieve sustained and beneficial impacts. Securing lasting improvements in fisheries management will require the commitment of all stakeholders to implement agreed actions.

The role of WWF is to provide organisational leadership for developing innovative, workable and cost-effective models and solutions for EBM and promoting their adoption across a range of global fisheries. We invite potential key partners to join us to develop and achieve a cooperative strategy and action plan to achieve this. Ensuring biodiversity conservation outcomes are given a high priority and describing how these outcomes are achieved is a critical indicator of the success of this work.

In summary the Delivery Mechanisms are:

1. promoting education about ecosystem-based management
2. developing models for stakeholder engagement
3. defining procedures for developing ecosystem-based management objectives, indicators and targets
4. ecosystem assessment of major global fisheries
5. promoting the benefits of fully-protected MPAs for fisheries
6. integrated regional planning and management
7. developing a Global Fishery Restructure Fund
8. case studies
9. developing guidance for other sectors.

Delivery Mechanism 1. *Education*

It is clear given the difficulties experienced in trying to operationalise EBM, and often expressed by fishery managers, fishers and some scientists, that a concerted effort is needed to educate those involved with fisheries management about the concept, principles and operational implementation of EBM. Because of the considerable differences in interpreting EBM in capture fisheries, an international, inclusive dialogue is needed to delineate the concepts, and build a broadly accepted common understanding of how to apply them in marine capture fisheries.

KEY ACTION 1

WWF is preparing this policy proposals paper, describing Ecosystem-Based Management for healthy marine ecosystems and marine capture fisheries, for global distribution. It outlines the governing principles and important aspects of the operational implementation of EBM, and seeks to catalyse a focused dialogue about the practical changes needed in daily fisheries management activities. WWF expects that such a dialogue amongst stakeholders, underpinned by concepts and information in this paper, will lead to an improved awareness of the EBM concept amongst fishers, fishery management agencies, and stakeholders.

Delivery Mechanism 2. *Developing Models for Stakeholder Engagement*

Successful Ecosystem-Based Management in marine capture fisheries requires comprehensive and effective stakeholder engagement within the operations of the fishery management system. The sustainability of fisheries is intimately linked to understanding the extent of ecosystem impacts, many of which are complex and subjective and require judgment and agreement amongst those with an interest in marine ecosystems, as well as fishery managers and the industry.

In fisheries management, the shift from a focus on sustaining production from a fish stock to a focus on healthy stocks and ecosystems is a crucial step that many fisheries managers have failed to manage effectively, and many still resist. Fisheries management systems, broadly speaking, are only weakly engaged with an appropriate range of stakeholders, and most offer only minimum levels of stakeholder participation in making decisions about target stocks, and even less for ecosystem issues and concerns.

The lack of stakeholder engagement often means that fisheries are at risk from the lack of consideration given to ecological issues, both the effects of the condition of the environment on the fishery and the effects of the fishery on the environment.

A failure to properly engage with scientific, conservation or community stakeholders may cause coastal developments to put fish habitat at risk and fishery operators and managers may not realise the fishery is affecting important non-utilised species or that fish stocks are declining. Public trust and confidence in fisheries management is in decline because of publicity about problems such as bycatch, impacts of trawling, and deaths of seabirds and marine mammals.

KEY ACTION 2

WWF believes a comprehensive evaluation of existing stakeholder engagement models is necessary in a range of resource sectors such as forestry, fisheries, watersheds, agriculture and tourism. Designing and implementing a project to identify 'best practice' models to be used for effective stakeholder engagement is a first step to completing this action. Evaluation needs to include the applicability of the models for assisting fisheries management to implement EBM in an effective manner and for their applicability to regional and international fishery management systems, commercial coastal fisheries and small-scale fisheries. The outcomes of this substantive review of existing practice needs to be published for wide distribution and made accessible to fishery managers across the full range of global fishery types.

Delivery Mechanism 3. *Defining Procedures for Developing Ecosystem-Based Management Objectives, Indicators and Targets*

For fishery management systems to be able to include the important elements of ecosystems within their ambit, a management approach for ecosystems needs to be developed that can be readily integrated into a typical fishery management system. It must be clearly understood by fishery managers, and be broadly compatible with most systems of management, i.e. not advocating a separate or entirely novel approach to management.

Many commercial fisheries conform broadly to the principles of *objective-based management*, i.e. the fishery is controlled to achieve objectives and targets for effort or catch. To integrate ecosystem issues within the fishery management system, a similar set of ecosystem elements parallel to those of the fishery management system needs to be developed, particularly for aspects of the ecosystem vulnerable to fishery activities. Identifying objectives and targets for ecosystems depends on a broad stakeholder involvement (see Key Action #2 above), but most importantly it also depends on a systematic, science-based information and design process.

The specific indicators and targets for assessing fishery performance need to be carefully designed using best available scientific models and data. Particular attention needs to be paid to conceptual models, cause-effect relationships, interacting factors external to the fishery (such as non-fishery impacts on habitats), a detailed analysis of the effort characteristics of the fishery, and the nature of the fishery information and ecosystem monitoring system. Approaches for identifying the high-risk ecosystem impacts of the fishery and identifying *ecosystem objectives* will depend on the life history of the utilised species, the type of fishery, the nature of habitats fished, the size and wealth of the fishery, and many other ecological and socio-economic factors.

The key obstacle to identifying ecosystem objectives to include in fishery management systems is our limited knowledge of ecosystems compared with our knowledge of utilised species. Even our knowledge about endangered species is generally so limited that adequate models cannot be constructed to include these species in a fishery management system in the same way as utilised species.

Knowledge is even more limited for habitats. For example, in demersal trawl fisheries, where impacts to benthic habitats and epifaunal species are usually key concerns, knowledge of life histories, reproductive cycles, growth or movement patterns of any of the species may be extremely limited. The relative ecological importance of these habitats and associated species for life cycles of the targeted fish is usually poorly defined or unknown. Consequently, continuing to degrade benthic habitats, whether deliberately or through the absence of robust management, is extremely risky.

A comprehensive EBM fisheries management system must consider the habitat that is directly critical to the life history of the target species. Additionally, other habitat may also be critical to other elements of the ecosystem, including species that the target species might prey on.

No fishery can anticipate collecting ecosystem data, or having access to such data, for more than a few non-target species. In these situations, ecosystem models must use crude surrogates as assessment endpoints *(ecosystem indicators)* that match their parallel fishery endpoints (such as population structure or breeding biomass). Such *ecosystem indicators*, and any specific targets that may be developed for them, will initially be only crude estimates of the integrity of ecosystems. A key step in EBM is refining ecosystem objectives and targets using local ecological knowledge, choosing the appropriate level of surrogacy and resolving power in relation to fishery impacts. However, there are few case studies or models for this process, and the need for this is not widely understood in fisheries or science circles.

KEY ACTION 3

WWF believes it is necessary to work closely with a small number of fisheries to design a robust scientific approach to developing suitable ecosystem objectives, indicators and targets for implementing EBM in a fishery. The procedure needs to follow a basic Ecosystem Assessment Procedure (see Key Action #4 below) customised for each fishery involved in the project. The approaches used need to be documented in detail, and successes and failures evaluated for publication and distribution to fishery managers and the scientific community. An early step in this process will be development of benchmarks and standards for ecosystem and stock management systems, and particularly the definition of operational standards for ecosystem structure and function that can be effectively linked to harvesting targets.

Delivery Mechanism 4. *Ecosystem Assessment of Major Global Fisheries*

To demonstrate the value of applying an EBM approach to fisheries management, an assessment of a variety of fisheries is necessary to evaluate the elements of the different management systems and their effectiveness in delivering EBM. Such an assessment would determine the comprehensiveness of the fishery management system against the requirements of an effective EBM system for each fishery, and highlight the gaps, i.e. any missing or poorly performing aspects. A basic checklist and audit procedure, including the following elements, could be used:

1. Fishery management system is in place and is effective.
2. Ecoregions are defined and used in the management system.
3. Habitats across the fishery have been defined.
4. Key species (threatened/endangered, structuring, high historic or cultural value, etc.) are defined and their critical habitats mapped.
5. Critical habitats for fishery and ecosystem functioning are defined and mapped.
6. Reserves to protect critical habitat are implemented jointly as biodiversity conservation and fisheries initiatives.
7. Habitat management is in place over the entire fishery area (including effective interfaces with other agencies).

8. Habitat impacts from fishing have been evaluated.
9. External threats to ecosystems have been evaluated.
10. Ecological Risk Assessments have identified key ecological issues and priorities.
11. Appropriate research is in place to improve the knowledge base about the fishery.
12. The nature of evidence used in making decisions in the fishery is comprehensive, and where there are major uncertainties, appropriately focused research programs are in place.
13. Objectives and targets in relation to fishery and environmental impacts are cautious, and provide for effective protection and conservation of utilised species and non-target habitats and species in the fishery.
14. Effective mechanisms for stakeholder participation in the management system, such as management advisory committees, are in place.
15. Extension services for training in innovative best environmental practice are in place, and related mechanisms to facilitate links between research and fishers are in place.

KEY ACTION 4

WWF invites key partners such as governments, inter-government organisations, non-government organisations, donors and fishers to jointly design and implement a project to make a progressive assessment of the management systems of a representative suite of major global fisheries in the context of EBM. The intention is to develop an agreed and robust approach to ecosystem assessment in order to assess and report on current practice, and to identify successful approaches to implementation of the EBM principles.

Delivery Mechanism 5. *Promoting the Benefits of Fully-Protected MPAs for Fisheries*

Many recent analyses of the role of Marine Protected Areas have highlighted the potential for fully protected reserves to contribute to both fishery and biodiversity conservation objectives. Fully protected reserves exclude recreational or commercial extraction of any resource, and where subsistence, artisanal and traditional use must occur, it is permitted only within defined and inclusively agreed ecological bounds and associated management arrangements.

Broad adoption of a system of fully protected reserves at an appropriate scale is possibly the *most significant single initiative* that could be implemented in the world's oceans to improve the conservation of marine biodiversity. Since such reserves could also be designed to protect against the effects of overfishing, and to assist the recovery of depleted stocks, combining these interests into a single inclusive global initiative is a very high priority.

There are three critical elements for gaining acceptance of a system of fully protected MPAs into fisheries management. These are; (1) identifying what benefits reserves can provide for fisheries, (2) identifying how reserves can be designed to deliver benefits jointly for biodiversity conservation and fisheries, and (3) promoting these benefits within fishing communities. In securing the support of fishers for these 'no-take' initiatives, it is crucial that the reserve design and boundaries achieve both biodiversity and fishery conservation objectives with the minimum possible disruption to use of the primary fishing grounds.

KEY ACTION 5

WWF believes it is critical that coastal and offshore fishery managers and relevant stakeholders design and implement a pilot fully-protected reserve system to provide demonstrated benefits to fisheries in economic and ecological terms. It is critical that fisheries involved have a strong and ongoing commitment to implement EBM through, for example, an adaptive process to implement a fully protected reserve system.

Delivery Mechanism 6. *Integrated Regional Planning and Management*

Fishing occurs alongside many other uses of marine and coastal areas. In most countries the environmental quality of estuarine, coastal and inshore marine areas is greatly influenced by discharges from the associated catchments/watersheds. Additionally, fishing activities in most countries are only weakly integrated with the activities of the many other users of the aquatic environment, e.g. subsistence fishers are usually ignored in the management of commercial fisheries; fishing and marine conservation are usually controlled by separate government agencies.

Thus, in implementing EBM, fisheries management cannot be considered in isolation, but integrated into regional planning and management initiatives. This is particularly relevant for inshore and estuarine fisheries where the interactions between various types of users, both terrestrial and marine, are greatest.

Only a few countries have attempted large scale integrated planning and management for marine systems, however, programs for integrated coastal zone management are underway in many parts of the world. The major challenges facing these initiatives are similar to those in fisheries management, namely:

- effective engagement of all stakeholders
- understanding cultural values and aspirations
- understanding the ecosystems and their functioning
- identifying critical habitats, threatened and endangered species
- establishing effective mechanisms for cooperation and collaboration between government agencies as well as between different levels of government, the private sector and the broader community.

KEY ACTION 6

It is critical to support, and where necessary, advocate and promote, relevant integrated regional planning and management programs, whether government or community-initiated. Where such initiatives are absent, WWF recommends cooperative programs be established. Where WWF is involved, it will seek to encourage these programs to fully incorporate the principles and practical implementation of EBM. Where WWF is unable to have a presence, WWF encourages other stakeholders to adopt a similar approach.

KEY ACTION 7

WWF believes it is necessary to monitor the implementation of a range of integrated regional planning and management programs such as the Oceans Policy in Australia, New Zealand, Canada and the US. Identifying and analysing any critical obstacles to achieving their objectives, and identifying opportunities to implement programs effectively will assist other countries to adopt similar programs.

Delivery Mechanism 7. *Developing a Global Fishery Restructure Fund*

The most widely cited issue in marine capture fisheries is over-capacity in fishing fleets, i.e. more boats with increasing power and technology pursuing more fish from dwindling populations. Over-capacity of fishing effort is not confined to industrial fleets. The same is true for the world's small-scale fisheries, which now face new environmental issues where traditional knowledge has no experience and provides no reliable guidance (Mathew 2001). The solution most often proposed is to restructure fisheries to reduce fishing effort to reduce extractions from fish stocks and make fisheries more sustainable.

However, the present-day investment and employment base for most fishing companies, and dependence of most communities and fishers on existing sources of income and food, requires a major investment in change management, and reliable leadership from the global community to reduce the current (increasing) levels of fishing. Achieving a reduction in effort whilst moving towards healthier fisheries and ecosystems and maintaining acceptable levels of income, food and employment for existing fishers, requires a comprehensive overhaul of economic and ecological incentive systems in the world's fisheries. We need targeted structural adjustment programs focusing on change management to reduce effort, as a temporary intervention.

Whilst the principles of EBM and the direction of change needed are clear, the process of making required changes is uncertain and, as with all reform agendas, will be resisted. The details will be different for almost every fishery, depending on the local culture, legislation, ecosystems, targeted stocks, and type of fishery management system. However, the required changes are usually at the local level, guided by national and international policies and principles.

In this context, restructuring fisheries to meet the principles of EBM needs considerable technical guidance across a range of areas, including many not traditional to fisheries management systems. These could include, for example

- eliminating perverse incentives
- funding schemes for buy-back of quota or other rights to fish
- identifying alternative income-generating opportunities for displaced fishers
- improving economic efficiency consistent with ecological sustainability
- improving marketing and distribution procedures to increase wealth generation from reduced catch levels
- setting feasible and achievable ecological objectives that can be incrementally attained
- increased monitoring, control and surveillance of areas closed to fishing to avoid increases in illegal, unreported and unregulated fishing.

The success of any fishery restructure will almost certainly depend on the incentives offered. Creating a permanent change in these incentive arrangements is the pre-condition for restructuring a fishery if lasting benefit is to be secured.

KEY ACTION 8

To develop and guide a process of global restructuring in fisheries, WWF calls on the global community to establish a Global Fisheries Restructure Fund (GFRF) for the benefit of fisheries and fishing communities at all scales. The primary purpose of the GFRF would be to facilitate the reduction of fishing capacity in the world's fisheries consistent with maintaining human and marine ecosystem well-being. Admission to restructuring programs of the GFRF would be open to fisheries anywhere, prioritised by their level of ecosystem impacts. Entry would however be dependent on the fishery agreeing to implement the principles and practices of EBM, to be independently audited against EBM objectives, and to participate in an active program of sharing of the lessons of successes and failures.

Design and implementation of the GFRF could be modelled on international trust fund ventures, provided they comply with key requirements for independence, efficiency, accountability and technical robustness in both program management and fishery outcomes. Funding for the GFRF may be achieved by specific donor contributions of operational funds and capital, by re-investment strategies, or by any effective means consistent with providing access to the GFRF by any fishery meeting the admission requirements. WWF would like to assist with the design and implementation of a GFRF, in partnership with a competent global authority with the charter to facilitate improved management of the oceans, marine ecosystems and fisheries.

The GFRF will need to be structured and managed to ensure it avoids the mistakes that have allowed some fishery restructuring programs to further subsidise the industrial fleets of developed nations.

Delivery Mechanism 8. *Specific Case Studies*

Case studies are an effective way to learn and demonstrate how to improve highly complex management systems, such as fisheries, where local flexibility is required and many aspects are highly uncertain. The key element of a specific case study is to analyse the processes that underpin successes and failures and inform fishery managers what to avoid, adapt or adopt.

WWF believes it is necessary to rapidly design and establish a series of systematic case studies that will demonstrate how to operationalise EBM in fisheries. These case studies could be designed to cover three types of fisheries:

1. regional fisheries, entailing international cooperation and coordination, and possibly including highly migratory species
2. commercial coastal fisheries, entailing local agency and stakeholder coordination, and possibly covering a multi-species fishery
3. small-scale fisheries, probably involving a community of subsistence fishers where models for EBM must be less data-intensive and greater flexibility in implementation is required.

Each case study should be designed and conducted in close partnership with fishery agencies, local, regional and global stakeholders, and donor partners, to be demonstration projects for implementing EBM in a fishery. These case studies should also be closely linked to the other global projects implementing these Key Actions, and provide real-world opportunities for applying and testing outcomes from the initiatives generated by the Key Actions.

KEY ACTION 9

WWF believes that designing and implementing a series of case studies in different fisheries will demonstrate where present Ecosystem-Based Management systems can be improved and what changes are necessary to more effectively move current management systems towards incorporating and operationalising more of the principles of EBM. These case studies could be initiated in a small number of specific fisheries, and closely linked to other global initiatives facilitating EBM. Lessons learned from these case studies should be documented, published and made available to all fisheries managers to encourage more effective and efficient implementation of EBM.

Delivery Mechanism 9. *Involving Other Marine Sectors in EBM*

This publication provides guidance on how to implement EBM for marine capture fisheries as a first step toward developing an internationally accepted, ecologically-based framework for the management of human activities in the world's oceans. WWF would like to work with other sectors that depend upon the marine environment to assist them in understanding how the EBM concept should be applied to them.

KEY ACTION 10

As resources permit, WWF will seek partnerships to develop an operational interpretation of Ecosystem-Based Management for other marine sectors including tourism, oil and gas and mining.

7

REFERENCES

Armstrong, C.W. & U.R. Sumaila. 2001 — Optimal allocation of TAC and the implications of implementing an ITQ management system for the North-East Arctic cod. *Land Economics*, 77, 350-359.

Aqorau T. 2001 — Obligations to protect marine ecosystems under international conventions and other legal instruments. Paper presented to *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

Australian State of the Environment Committee. 2001 — *Australia State of the Environment 2001.* Independent Report to the Commonwealth Minister for the Environment and Heritage, CSIRO Publishing on behalf of the Department of the Environment and Heritage, Canberra.

Baker, C.M., B.J. Bett, D.S.M Billett & A.D. Rogers. 2001 — An environmental perspective. In: (Eds. WWF/IUCN). *The Status of Natural Resources on the High-Seas.* WWF/IUCN, Gland, Switzerland.

Bonfil, R., G. Munro, U.R. Sumaila, H. Valtysson, M. Wright, T. Pitcher, D. Preikshot, N. Haggan & D. Pauly. 1998 — *The Footprint of Distant Water Fleets on World Fisheries.* Endangered Seas Campaign. WWF International, United Kingdom.

Butterworth D.S. & A.E. Punt. 2001 — The role of harvest control laws, risk and uncertainty and the precautionary approach in Ecosystem-Based Management. Paper presented to *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

Comunidad y Biodiversidad (CoBi). 2000 — *Community-based sustainable fisheries in Baja California: A pre-investment analysis to start a fisheries certification program.* Submitted to WWF US, WWF Endangered Seas Campaign, WWF Mexico. September 2000.

Christensen N. L., A. M. Bartuska, J. H. Brown, S. Carpenter, C. D'Antonio, R. Francis, J. F. Franklin, J. A. MacMahon, R. F. Noss, D. J. Parsons, C. H. Peterson, M. G. Turner & G. G. Woodmansee. 1996 — *The report of the Ecological Society of America Committee on the scientific basis for ecosystem management. "Ecological Applications* 6: 665-691."

Commonwealth of Australia. 1998 — *Australia's Oceans Policy.* Volumes I and II. Environment Australia, Canberra, Australia. 48 pp + 48 pp.

Cortner H. J. & M. A. Moote. 1999 — *The Politics of Ecosystem Management.* Island Press, Washington DC.

Cury P., L. Shannon & Y-J. Shin. 2001 — The functioning of marine ecosystems. Paper presented to *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

Dayton P. K., M. J. Tegner, P. B. Edwards & K. L. Riser. 1998 — Sliding baselines, ghosts, and reduced expectations in kelp forest communities. *Ecological Applications* 8: 309–322.

de Fontaubert, A.C. 2001 — Legal and political considerations. In: (Eds. WWF/IUCN). *The Status Of Natural Resources On The High-Seas.* WWF/IUCN, Gland, Switzerland.

Ecosystem Principles Advisory Panel. 1998 — *Ecosystem-Based Fishery Management*. A report to Congress by the Ecosystem Principles Advisory Panel. 54pp.

Edwards M. 1999 — *The Administration of Fisheries Managed by Property Rights*. FishRights 99 Mini-course. FAO/Fisheries WA Symposium, Perth WA.

FAO 2001 — Background paper prepared for the *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

Garcia, S.M. & I. de Leiva Moreno. 2001 — Global Overview of Marine Fisheries. Paper presented to *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

Grafton, R.Q. 1996 — Individual transferable quotas: Theory and practice. *Reviews in Fish Biology and Fisheries*, 6 (1): 5–20.

Great Barrier Reef Marine Park Authority. 2001 — *Great Barrier Reef Catchment Water Quality Action Plan*. Great Barrier Reef Marine Park Authority, Townsville, Australia. 64 pp.

Hannesson, R. 1996 — On ITQs: An essay for the special issue of Reviews in Fish Biology and Fisheries. *Reviews in Fish Biology and Fisheries* 6 (1): 91–96.

Harwell, M.A, J.F.Long, A.M. Bartuska, J.H. Gentile, C.C. Harwell, V. Myers, & J.C. Ogden 1996 — Ecosystem management to achieve ecological sustainability: the case of South Florida. *Environmental Management* 20, 497–521.

Holling C. S. 1996 — Surprise for science, resilience for ecosystems, and incentives for people. *Ecological Applications* 6, 733–735.

Jackson J. B. C., M. X. Kirby, W. H. Berger, K. A. Bjorndal, L. W. Botsford, B. J. Bourque, R. H. Bradbury, R. Cooke, J. Erlandson, J. A. Estes, T. P. Hughes, S. Kidwell, C. B. Lange, H. S. Lenihan, J. M. Pandolfi, C. H. Peterson, R. S Steneck, M. J. Tegner & R. R. Warner. 2001 — Historical overfishing and the recent collapse of coastal ecosystems. *Science*, 293: 629–638.

Kock, K.H. 2000 — Understanding CCAMLR's Approach to Management. CCAMLR website, **www.ccamlr.org**

Martin W., M. Lodge, J. Caddy & K. Mfodwo. 2001 — *A Handbook for Negotiating Fishing Access Agreements.* WWF US.

Mathew, S. 2001 — Small scale fisheries perspectives on an ecosystem-based approach to fisheries management. Paper prepared for the *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

McGoodwin, J.R. 1990 — *Crisis in the World's Fisheries.* Stanford University Press: Stanford, California.

O'Connor, S., J. Martin-Jones & E. Tamale. 2000 — Putting the ecosystem approach to practice – Lessons learned from WWF's initiatives. Position Paper in: *Fifth Meeting of the Conference of the Parties to the Convention on Biological Diversity, Nairobi, Kenya, 15–26 May 2000.* WWF: Gland, Switzerland. 9pp.

Pauly, D., Christensen, V., Froese, R., Longhurst, A., Platt, T., Sathyendranath, S., Sherman, K., & Watson, R., 2000 — Mapping fisheries onto marine ecosystems: a proposal for a consensus approach for regional, oceanic and global integrations. ICES 2000 *Annual Science Conference.* Theme Session on Classification and Mapping of Marine Habitats CM 2000/T:14. 15pp.

Pirot, J.Y., P.J. Meynell & D. Elder. 2000 — *Ecosystem Management: Lessons from Around the World. A Guide for Development and Conservation Practitioners.* IUCN, Gland, Switzerland.

Pitcher, T.J. 2001 — Fisheries managed to rebuild ecosystems: reconstructing the past to salvage the future. *Ecological Applications,* 11 (2): 601–617.

Pitcher, T.J. & D. Pauly. 1998 — Rebuilding ecosystems, not sustainability, as the proper goal of fishery management. Pages 311–329, In: (Eds. Pitcher, T.J., P.J.B. Hart & D. Pauly) *Reinventing Fisheries Management,* Chapman & Hall, London. 435 pp.

Punt, A.E. & A.D.M. Smith. 1999 — Harvest strategy evaluation for the eastern stock of gemfish *(Rexea solandri). ICES Journal of Marine Science,* 56: 860–875.

Punt, A.E., A.D.M. Smith & G. Cui. 2001 — Review of progress in the introduction of Management Strategy Evaluation (MSE) approaches in Australia's South East Fishery. *Marine and Freshwater Research,* 52: 719–726.

Restrepo V. R., G. G. Thompson, P. M. Mace, W. L. Gabriel, L. L. Low, A. D. MacCall, R. D. Methot, J. E. Powers, B. L. Taylor, P. R. Wade & J. F. Witzig. 1998 — *Technical Guidance on the Use of Precautionary Approaches to Implementing National Standard 1 of the Magnuson Stevens Fishery and Management Act.* NMFS, NOAA. NMFS Tech. Mem. (available at **www.nmfs.gov/sfa/reports.html**)

Roberts, C.M. & J.P. Hawkins. 2000 — *Fully Protected Marine Reserves: A Guide.* WWF Endangered Seas Campaign, 1250 24th Street, NW, Washington, DC 20037, USA and Environment Department, University of York, York, YO10 5DD, UK.

Sainsbury, K.J., A.E. Punt & A.D.M. Smith. 2000 — Design of operational management strategies for achieving fishery ecosystem objectives. *ICES Journal of Marine Science,* 57: 731–741.

Sainsbury K. & U.R. Sumalia. 2001 — Incorporating ecosystem objectives into management of sustainable marine fisheries including 'best practice' reference points and use of marine protected areas in Ecosystem-Based Management. Paper presented to *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

Salz, P. 1996 — International Council for the Exploration of the Sea, Copenhagen (Denmark), Theme Session on Management Faced with Multiple Objectives. ITQs in the Netherlands: Twenty years of experience. *Council Meeting of the International Council for the Exploration of the Sea, 27 Sep–4 Oct. 1996, Reykjavik (Iceland).* ICES Council Meeting Papers. Copenhagen (Denmark): ICES, 17 pp.

Siegel, S.R. 2000 — Applying the habitat conservation model to fisheries management: A proposal for a modified fisheries planning requirement. *Columbia Journal of Environmental Law,* 25 (1), 141–212.

Sissenwine M.P. & P.M Mace. 2001 — Governance for responsible fisheries: an ecosystem approach. Paper presented to *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem*. Iceland, 1-4 October 2001.

Smith, A.D.M., K.J. Sainsbury & R.A. Stevens. 1999 — Implementing effective fisheries management systems – management strategy evaluation and the Australian partnership approach. *ICES Journal of Marine Science,* 56: 967–979.

Sumaila, U.R. 2002 — *Generational cost benefit analysis for evaluating marine ecosystem restoration*. Fisheries Centre Research Report, in press.

Sutinen J.G. & M. Soboil. 2001 — The performance of fisheries management systems and the ecosystem challenge. Paper presented to *Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem. Iceland, 1–4 October 2001.*

Symes, D. & J. G. Pope 2000 — *An ecosystem approach to the Common Fisheries Policy: Achieving the objectives.* Peterborough, English Nature. 52 pp.

US Environmental Protection Agency. 1998 — *Guidelines for Ecological Risk Assessment.* (Published on May 14, 1998, Federal Register 63 (93): 26846–26924). U.S. Environmental Protection Agency, Washington, DC.

Walters, C. & P.H. Pearse. 1996 — Stock information requirements for quota management systems in commercial fisheries. *Reviews in Fish Biology and Fisheries,* 6 (1): 21–42.

Ward T. J. & C.A. Jacoby. 1995 — Deciphering spatio temporal dynamics: what can mesocosm experiments do to improve predictions of environmental impacts? *Australasian Journal of Ecotoxicology* 1: 51–54.

Ward, T., J. Alder, C. Margules, K. Sainsbury, D. Tarte & L. Zann. 1997 — *Australia's Oceans Policy: Biodiversity Conservation*. Issues Paper 7. Environment Australia, Canberra, Australia. 54 pp.

Ward, T., D. Heinemann & N. Evans. 2001 — *The Role of Marine Reserves as Fisheries Management Tools. A Review of Concepts, Evidence and International Experience.* Bureau of Rural Sciences, Canberra, Australia. 192 pp.

Watson, R. & D. Pauly. 2001 — Systematic distortions in world fisheries catch trends. *Nature* 414: 536–538.

WWF International. 1998 — *The Footprint of Distant Water Fleets on World Fisheries.* Endangered Seas Campaign, WWF International.

WWF / IUCN. 1998 — *Creating a Sea Change.* WWF/IUCN, Gland, Switzerland.

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GLOSSARY OF TERMS

Adapted from the text, as well as from the FAO Fisheries website ***(www.fao.org/fi/glossary/default/asp)****, Australia State of the Environment 2001, Ward et al. (1997) and Holling (1996).*

adaptive management Management that adapts by learning from specific interventions designed to improve knowledge in the fishery and models of fishery structure, function and management. The process involves step-wise evolution of a flexible management system in response to feedback from within the system on biological, social or economic matters. It depends on a willingness to describe and promulgate both failures and successes in management.

artisanal fishery — Traditional fishery involving fishing households (as opposed to commercial companies), using relatively small amount of capital and energy, relatively small fishing vessels (if any), making short fishing trips, close to shore, mainly for local consumption. In practice, definition varies between countries – from a one-person canoe in poor developing countries, to more than 20 m trawlers, seiners, or long-liners in developed nations. Artisanal fisheries can be subsistence or commercial fisheries, providing for local consumption or export; may be conducted using low-impact culturally traditional fishing gear or modern fishing methods; sometimes also referred to as small-scale fisheries.

assessment endpoint — The combination of *performance indicator* and *target* used to determine if an activity has succeeded in response to a specific management activity or intervention.

baseline — In *monitoring*, the defined natural (background) variability in a suite of indicators across space and time; the starting or natural position from which a deviation is recorded.

benchmark — The point of reference for making a comparative evaluation of performance; the standard established for a level of performance.

biological diversity (biodiversity) — The variability among living organisms from all sources (including terrestrial, marine, and other ecosystems and ecological complexes of which they are part) and includes diversity within species and between species, diversity of ecosystems, and the ecological processes that maintain the ecosystems.

biomes — A high level classification of the world's natural systems, as in ocean, grassland, forest, tundra; UNESCO has designated 14 global biomes.

bioregions — A territory defined by a combination of biological, social and geographic criteria rather than by geopolitical considerations; generally, a system of related, interconnected ecosystems.

burden of proof — The responsibility for making the case and proving an adopted position or statement is true.

bycatch — The catch taken in fishing that is incidental to the main species being sought; may be retained or returned to the ocean.

conservation status — The extent to which an ecosystem, habitat or species is well protected *in situ*; takes account of threatening processes and any trends in population size or potentially threatening processes.

Consultative Council — Stakeholder groups with a focus on particular ecosystems of fisheries, such as the Pacific Whiting Conservation Council in the Pacific Northwest of the US.

critical habitat — Habitat that is required by a species for the normal completion of its life cycle and evolutionary development; the obligate association between a species and a habitat; the habitat that provides a vital service for species of commercial interest, as in breeding grounds or nursery areas.

dependent species — Species related to a focal species by ecological interaction, such as being a competitor for space, a predator or a prey of the focal species.

ecological integrity — The state of the ecosystem or its elements being natural, whole and unimpaired, determined by reference to appropriate ecosystem indicators and criteria.

Ecological Risk Assessment — The process of determining the ecological risks of fishing to ecosystems, and assigning priorities to consequent actions, in conjunction with *partners* and *stakeholders*.

ecological sustainability — The use of species or ecosystems within the capacity of the species, ecosystem or *bioregion* to sustain natural processes, to renew or regenerate consistent with maintaining *ecosystem integrity*, and ensuring that the benefits of the present use do not diminish the potential to meet the needs and aspirations of future generations.

ecological values — The value of ecosystems, habitats and species for their biological diversity, uses (such as fishing, recreation), cultural identity, inspiration, and the provision of ecological services such as nutrient assimilation .

ecologically-based decision rules — Decision rules in fisheries management that are designed to take account of the specific needs of ecosystems or habitats within ecosystems, or non-target species, such as top-level predators or threatened species, and/or are designed to take account of the impact of fishing on the ecosystem as an element of managing the target stock.

ecoregions — *Bioregions* that are defined on mainly ecological criteria.

ecosystem — A dynamic complex of plant, animal and microorganism communities and their non-living environment interacting as a functional unit.

Ecosystem-Based Management — *Management* of the uses and values of ecosystems in conjunction with *stakeholders* to ensure *ecological integrity* is maintained, and recognising that ecosystems are dynamic and inherently uncertain.

ecosystem function — The interactions of components of ecosystems, including energy production and consumption, transport of propagules, and biological interactions such as predation.

ecosystem management — A synonym for *Ecosystem-Based Management*; often interpreted incorrectly to imply management of ecosystems, but more correctly interpreted to mean management of human activities that affect ecosystems, often detrimentally.

ecosystem productivity — The flow of biomass and energy within and between trophic levels in ecosystems, habitats and species; normally includes all forms of primary and secondary production in plants and animals, including harvested species.

ecosystem structure — The structural components of ecosystems, including biological diversity, water and non-living substrates.

environment — Ecosystems and their constituent parts, including people and communities, natural and physical resources, the qualities and characteristics of places and areas, and the social, economic and cultural aspects of all of these features.

escapement — The number or proportion of fish surviving (escaping from) a given fishery at the end of the fishing season and reaching the spawning grounds or spawning size.

eutrophication — The condition, usually limited to bays, rivers, estuaries, lakes and similar enclosed waters, where excess nutrient pollution causes undesirable, and sometimes toxic, large growths of marine plants or *phytoplankton*; has major impacts on *biological diversity*, on fishing, tourism, recreation and many other uses of coastal environments.

externalities — Factors that originate from outside the normal range of a *management system*.

fish stock	Biological populations of species that are commercially fished, and readily traded in the seafood sector, including crustaceans, teleosts, elasmobranchs, and molluscs.
fishery productivity	The catch from a fishery.
genetic diversity	The diversity of the gene pool that resides within species and their populations.
habitat	The place or type of site that organisms normally inhabit; may include living or non-living structures (such as seagrass or sediment).
harvest strategy	Describes how the harvest is intended to be controlled by management in relation to the state of some indicator of stock status. For example, a harvest strategy can describe the various values of fishing mortality to be applied in order to achieve various values of stock abundance. It formalises and summarises a management strategy. Constant catch and constant fishing mortality are two types of simple harvest strategies.
icon species	Species that are well known to the public or are emotive and symbolic for conservation causes, often *threatened* or *protected species*.
important species	Species of social, cultural, or economic significance, as well as species that have key roles in ecosystems.
industry sectors	High level classification of users of the marine ecosystems and oceans; includes tourism, mining, oil/gas, fishing, recreation, and many more.
input control (in fisheries management)	Fishery management measures imposed on 'inputs' to the fishery, such as number of vessels permitted to fish, size of gear approved for fishing, places and times where fishing is banned.
integrated regional planning and management	Planning and management organised so that processes are integrated across natural ecological boundaries, geopolitical boundaries and jurisdictions, *industry sectors*, and programs of government activity; regions normally are considered to be large, such as in *large marine ecosystems* but smaller than ocean basins.
large marine ecosystem	Relatively large regions of the ocean, about 200 000 km^2 or more, characterised by distinct bathymetry, hydrography, productivity, species composition, and trophically inter-dependent populations.
limit reference point (LRP)	Indicates the limit beyond which the state of a fishery and/or a resource is not considered desirable or acceptable. Fishery development should be stopped before reaching the LRP. If a LRP is inadvertently reached, management action should severely curtail or stop fishery development, as appropriate, and corrective action should be taken. Stock rehabilitation programs should use the LRP as a very minimum rebuilding target to be reached before the rebuilding measures are relaxed or the fishery is re-opened.
living marine resources	Marine species that may be harvested for food, shelter, or other uses such as chemicals, pigment or protein extraction.
management	The process of controlling human activities; usually based on a coordinated system of planning, implementation and evaluation.
Management Advisory Committee	A consultative structure used in Australia to provide advice on management; includes representatives from the fishery, science and conservation non-governmental organisations.

management system (in fisheries management) The institutions, the processes and the legislative or cultural basis for controlling fishing, including providing for its planning, review, assessment and information support.

marine protected area Marine area where the protection and conservation of biological diversity is the prime objective of management; includes areas that are fully protected from all human activities, '*no-take' areas*, areas set aside for some forms of recreation and cultural appreciation, and areas where low-impact sustainable harvesting of natural resources is permitted.

monitoring The act of taking repeated measurements of indicators to ascertain the nature and extent of change over space and time (natural variability); usually in accord with a plan that defines the sampling protocol, and the way in which data will be interpreted and reported.

no-take area *Marine protected area* where the taking of living or non-living material is prohibited; may be used for low-impact recreation or tourism that is intensively managed; a Marine Fisheries Sanctuary created in support of a fishery.

objective-based management *Management* that uses agreed objectives expressed as intended outcomes as the basis for planning and control.

output controls (in fisheries management) Fishery management measures imposed on 'outputs' from the fishery, such as number or weight of fish permitted to be caught, landed, or sold.

overfishing Catching more fish than can be supported by a sustainable fishery; there are 5 recognised types of overfishing—growth, recruitment, genetic, serial, and ecosystem.

paleo-ecology The science of ecology as revealed by sampling and analysis of historic data and information, often by analysis of substrate samples, fossils and ancient records.

partner (in management) A *stakeholder* who has a vital and direct interest in a fishery or the environment where it operates; includes fishers, boat owners, local conservation groups, government conservation agencies, local development agencies.

performance indicator The variable being measured to determine if a level of performance has been achieved by reference to a target or *benchmark* level of performance; the variable measured in a *monitoring* program.

phytoplankton Microscopic mainly single-celled photosynthesising plants that live in the upper (sunlit) zones of the oceans and estuaries; they are not attached to substrate and float in the water column.

population diversity The distribution of sizes, ages and the spatial distribution of individuals of a species within a population of animals, plants or microorganisms.

precautionary approach Taking decisions that err on the side of conservation when there is substantial *uncertainty* or a significant risk that assumptions or model failure would detrimentally affect biological diversity; includes provisions in management that will ensure that all issues that may lead to significant risk to biological diversity are included within the decision-making process; implemented by ensuring that a lack of scientific certainty does not preclude decisions and consequent actions that err on the side of conservation. Includes future courses of action, which ensures prudent foresight, and to the extent possible, takes explicitly into account existing uncertainties and the potential consequences of decisions being wrong.

precautionary decision rules Rules in fishery management that implement the principle of the *precautionary approach*, and specifically in relation to target fish stocks.

productivity (in a fish stock) Relates to the birth, growth and death rates of a stock. A highly productive stock is characterised by high birth, growth and mortality rates, and as a consequence, a high turnover and production to biomass ratios (P/B). Such stocks can usually sustain higher exploitation rates and, if depleted, could recover more rapidly than comparatively less productive stocks.

protected species Species that are identified in species-specific protective legislation.

reference point (in fishery management) A reference point indicates a particular state of a fishery indicator corresponding to a situation considered as desirable (target reference point, TRP) or undesirable and requiring immediate action (limit reference point, LRP, and threshold reference point, ThRP).

resilience The ability of *ecosystems* to absorb change and variation without flipping into a different state where the variables and processes controlling structure and behaviour suddenly change.

science-controlled (management) Process that is dependent for implementation on progress in scientific knowledge and unable to be implemented without scientific resolution of issues (see *science-supported; precautionary approach*).

science-supported (management) Process that is implemented using scientific knowledge in support of decisions and activities, but not controlled by progress in scientific research such that precautionary decisions cannot be made until scientific uncertainty is resolved.

sedimentation The infilling of rivers, bays and estuaries with sediment or other unconsolidated material, often derived from land-based activities such as inappropriate agricultural practices, but may also be caused by mining or coastal developments.

spatial management framework A set of principles, elements and constraints that, amongst others, provide a spatial structure to guide *management* of a natural resource within the *management system*.

stakeholders Any person, group or agency that has an interest in the fishery, its performance, or the environment where the fish live or the fishery is conducted (see *partner*).

stock assessment The process of collecting and analysing biological and statistical information to determine the changes in the abundance of fishery stocks in response to fishing, and, to the extent possible, to predict future trends of stock abundance. Stock assessments are based on resource surveys; knowledge of the habitat requirements, life history, and behaviour of the species; the use of environmental indices to determine impacts on stocks; and catch statistics. Stock assessments are used as a basis to assess and specify the present and probable future condition of a fishery.

stock assessment models The conceptual, statistical or process model that provides the basis for *stock assessment*.

subsidies and incentives Mechanisms or programs invoked, usually by governments, to change behaviour of industry sectors; they may involve direct or indirect financial allocations or cost savings, support for infrastructure development, change in the taxation structure, non-monetary rewards such as prizes or appointments, and may be related to other subsidies such as fuel subsidies for all sectors.

target	The quantitative level of a *performance indicator* intended to be achieved within a management system.
threatened species	Species that are vulnerable to extinction or are endangered.
Total Allowable Catch	The TAC is the total catch allowed to be taken from a resource in a specified period (usually a year), as defined in the management plan. The TAC may be allocated to the stakeholders in the form of quotas as specific quantities or proportions.
traditional ecological knowledge	Knowledge about ecosystems and *biological diversity* held by communities as a result of generations of experience with coastal living, fishing, or seafaring; may be held in written records or in oral history.
uncertainties	Weaknesses in knowledge about aspects of ecosystems, institutions and fisheries management, and the way in which they interact; includes lack of data, lack of understanding about how processes work, and inability to predict consequences of future actions.
virgin biomass	Known as B_0 or Bv. The average biomass of a stock that has not been fished. Biomass of an unexploited stock. Most often inferred from stock modelling. Used as a reference value to assess the relative health of a stock, through monitoring changes in the ratio between current and virgin biomass (B/B_0). It is usually assumed that, in absence of better data, that $B = 0.30 B_0$ is a limit below which a stock should not be driven.

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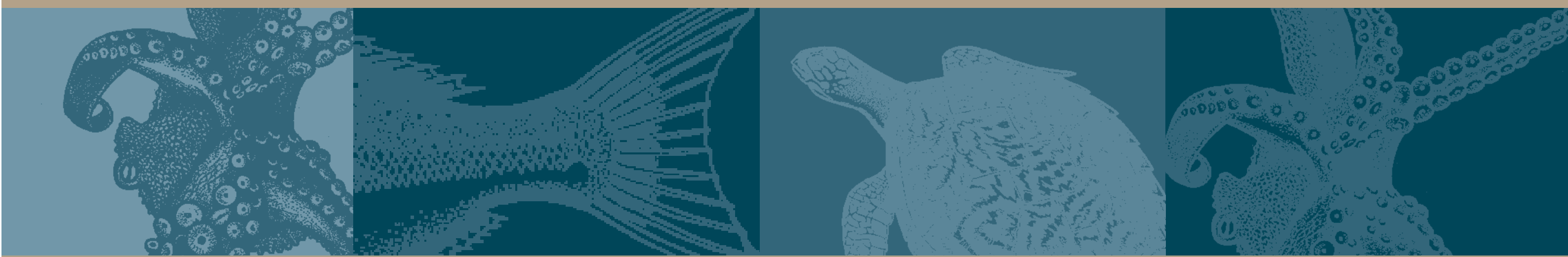
WWF is one of the world's largest and most experienced independent conservation organizations, with almost 5 million supporters and a global network active in more than 90 countries.

WWF's mission is to stop the degradation of our planet's natural environment and to build a future in which humans live in harmony with nature, by:

- conserving the world's biological diversity
- ensuring that the use of renewable natural resource is sustainable
- promoting the reduction of pollution and wasteful consumption.



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