

The Policy Basis of the “Ecosystem Approach” to Fisheries Management

W R Turrell

Fisheries Research Services
Marine Laboratory
375 Victoria Road
Aberdeen AB11 9DB
UK

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1 Foreword

What is the “ecosystem approach”?—a question many people are presently considering. For a physical oceanographer such as myself it is a new term, but one increasingly heard. The phrase is repeated in numerous policy statements of environmental, conservation and fishery organisations, both governmental and non-governmental. The phrase also now appears in almost all marine science funding proposals, or calls for proposals. Almost invariably each time the term is used it is followed by a mysterious mantra, presented as a citation, such as “UNCLOS, the Rio Declaration, the UN Convention on Biological Diversity, the Jakarta Mandate, Agenda 21, World Summit on Sustainable Development, and the FAO Code of Conduct for Responsible Fisheries”. Such lengthy citations are copied from proposal to proposal, losing not only their meaning, but also their relevance. As a physicist who has worked in marine science in a fisheries context for more than 15 years, I had no idea what these cited mysteries were, or what they actually said about the “ecosystem approach”.

In 2003, the ICES–IOC Steering Group on GOOS (SGGOOS) decided that a simple guide to the numerous international policy documents was needed. This review paper arises from a short study leave spent at the Bedford Institute of Oceanography, Halifax, and kindly hosted by Glen Harrison, the IOC co-chair of SGGOOS. Its purpose is to summarise, and in some ways interpret, the international policy drivers lying behind the “ecosystem approach”. It has been written by a marine scientist, with marine scientists in mind, but may also be of use to anyone working on the many and varied aspects of the “ecosystem approach”. It takes a somewhat historical view, and attempts to trace the origin of the term itself.

This review comes to some conclusions, which may be naïve but which arise from a scientist’s interpretation of policy. In summary, the “ecosystem approach” is a simple concept, made complex by numerous layers of sometimes unhelpful debate. The “ecosystem approach”, if it is to succeed, will need fundamental reorganisation of both our governmental and scientific organisations. ICES has recognised this, and started in 2004 with a restructuring of the Secretariat, and a reformatting of the advice it provides to its client commissions. The new advice format focuses on ecosystems

rather than single stocks. My own community, physical oceanography, is fundamental to the success of the “ecosystem approach” but is perhaps the community most ignorant of the changes which are beginning to sweep through marine science. Currently much of physical oceanography serves the Convention on Climate Change, rather than the Biological Diversity Convention with its “ecosystem approach”. I hope this review may help my colleagues to understand where the “ecosystem approach” has come from, and what it might need in terms of scientific support.

I am grateful to Hans Dahlin and EuroGOOS for their publication of this review.

Bill Turrell

*Marine Ecosystems Science Director
Fisheries Research Services
Marine Laboratory, Aberdeen*

EuroGOOS is pleased to publish this review by Bill Turrell, co-chair of the ICES–IOC Steering group on GOOS (SGGOOS). An “ecosystem approach” has to be based on observations and research, and consequently provides design criteria for GOOS and the regional European GOOS system. EuroGOOS has participated actively in both the SGGOOS and in the ICES–EuroGOOS Planning Group for the North Sea Pilot project in order to understand the requirements on operational oceanography from fisheries management and to plan for initial services.

I hope that the EuroGOOS members and others can find support and justification in this report for the development of European operational oceanography. It is the intention of EuroGOOS to continue the work by reviewing other parts of the international legal framework for operational oceanography.

Hans Dahlin

Director EuroGOOS

2 Abstract

Global societal concerns regarding man's use of the natural resources of the planet have been translated into marine policy, since 1945, within three strands of global ocean governance. These three routes have led through the UN Convention on the Law of the Sea (UNCLOS), the UN Conferences on Environment and Development (UNCED), and the UN Food and Agriculture Organisation (FAO). This review paper charts the progress, via the three main routes, of the underlying principles which have resulted in the concept of an "ecosystem approach" to fisheries management. Perhaps the most fundamental description of the basis of an "ecosystem approach" was first formalised by the Stockholm Declaration in 1972. Here Governments expressed the wish to work towards integrated, holistic, science-based management employing decentralised, transparent decision-making involving local communities and users. These original founding concepts have been reaffirmed over the past three decades in numerous declarations and agreements made within the three policy areas, but have been slowly enveloped in confusing detail describing the scientific tools that are needed to operate an "ecosystem approach". While the development of ecosystem science and tools (e.g. monitoring, indicators, ecological objectives, status reports, ecosystems models, Marine Protected Areas and pilot projects) continues to develop at a rapid and expanding pace, it may be argued that the original concepts of an "ecosystem approach", repeated through all three policy strands, have been neglected. In many ways, the science of an "ecosystem approach" is the more simple aspect. The fundamental changes needed within national, regional and international scientific and governmental institutions are the more difficult, and hence are presently being overlooked.

3 Introduction

At the present time (2004), fishery scientists are endeavouring to develop the tools that are needed to implement an “ecosystem approach” to fisheries management. However, the precise meaning of the term is not currently well defined. Indeed, no single definition is possible as the approach must vary depending on local and regional differences between fisheries, and between the ecosystem within which these fisheries are pursued. However, the underlying principles of an “ecosystem approach” are generic. These principles have arisen over a considerable length of time, and from global-scale consultation orchestrated within the scientific and political sectors. This paper charts the progress of concepts underpinning the “ecosystem approach” in order to understand where it has come from, and provide some insight into where we should be heading in terms of the implementation of the approach.

Another rationale for this review paper is the recognition that the “ecosystem approach” to fisheries management will rely on the coming together of communities of scientists who, in the past, have either never had meaningful dialogue with each other or have never been exposed to the global ocean governance policy requirements that currently drive us towards a holistic managerial mechanism. One specific example is the physical oceanographic, or ocean process, community. Another is the research and academic community. These sectors, by necessity, must be involved in any valid “ecosystem approach”, but in the past have generally operated without the need to service higher level policies, particularly those related to fisheries management. In order for each community to understand the needs of the other, and more importantly to understand the requirements of managers of both the environment and fisheries for new types of information and advice, the high level international policy drivers need to be understood.

Many marine scientists, and some managers, are only ever exposed to the local, national or regional implementation of international ocean governance policies, and hence do not understand their background, their underlying concepts or how they have been developed. Such an overview or insight is important for the future, if we are to evolve towards a common vision of an “ecosystem approach” to fisheries and environmental management, and a vision which fulfils the initial

societal wishes which started the political process leading to the policies we are attempting to formulate today.

In addition to the cross-community issue, many strategic plans, action plans, operating plans and grant proposals, at local, national, regional and international scales, refer to the plethora of high level global ocean governance policy drivers. Often references to these policy instruments simply propagate from one secondary source to the next, without the authors really understanding the origins of the primary source cited or its underlying concepts. This propagation is quite dangerous, as it strengthens scientists’ increasing focus on the details of an “ecosystem approach”, while allowing them, and their customers, to overlook the outcome which the “ecosystem approach” is trying to achieve.

This review paper attempts to summarise the principle components of the complex, inter-related network of global ocean governance policy drivers which are of relevance to marine ecologists and managers working on issues connected with habitat, fish stock, fishery, environment and ecosystem management.

The Role of ICES, EuroGOOS and Operational Oceanography in the “Ecosystem Approach”

The International Council for the Exploration of the Seas (ICES) is an inter-governmental organisation which co-ordinates marine science in the North Atlantic region, including adjacent seas such as the Baltic and North Sea (www.ices.dk). Scientists working through ICES gather information about the marine ecosystem and develop this information into unbiased, non-political advice. The advice is then used by the 19 member countries, which fund and support ICES, to help them manage the North Atlantic Ocean and adjacent seas.

ICES recognised the importance of developments towards the Global Ocean Observing System (GOOS), and established the ICES / IOC Steering Group on GOOS (SGGOOS), which fosters links between international GOOS and ICES.

In parallel to ICES activities in the north east Atlantic, EuroGOOS was established, with many members of EuroGOOS also contributing to various aspects of ICES work.

In the North Sea, the joint ICES / EuroGOOS Planning Group for the North Sea Pilot Project (PGNSP) is attempting to steer progress towards the use of operational oceanography in the context of fisheries management.

Several boxes through this review present aspects of ICES, EuroGOOS and operational oceanography relevant to developing an “ecosystem approach” to fisheries management in the NE Atlantic region.

4 Three Strands of Global Ocean Governance

When analysing global policy drivers related to marine ecosystems, three principal strands may be recognised (Figure 1); one leading to the UN Law of the Sea (UNCLOS), one focusing on the UN Conferences on Environment and Development (UNCED), and one steered by the UN Food and Agriculture Organisation (FAO). Each strand has influenced the other, and each has been influenced by external conferences, declarations, committees, working groups and organisations. Recurring themes, as well as old and new concepts emerge throughout the three separate strands (Table 1). Individual nations have signed up to different instruments arising from these policy strands (Table 2), and the instruments vary in legal status from non-binding visions for the future, to formal

international agreements enforceable in international courts (Figure 1).

It might be argued that each of the three strands may be traced back to the global societal needs and aspirations that were generated by the deprivations and experiences mankind went through during the two world wars. These needs were expressed by the public through the politicians who established the United Nations in 1945.

Of course, international marine cooperation and policy making existed prior to 1945, and in fact the International Council for the Exploration of the Sea (ICES) could be held up as an example of different nations within a region recognising the need for a common understanding, dialogue and management

Year	UNCLOS	United Nations UNCED	FAO
1945			UN Food and Agricultural Organisation
1965	Influences: Arvid Pardo—"the deep sea is the common heritage of mankind", "all aspects of ocean space are interrelated and should be treated as a whole"		FAO Fisheries Committee
1972	UN Conferences on the Law of the Seabed (1958, 1960) International Ocean Institute—Pacem in Maribus Conferences (annually, starting in 1970)	UN Conference on the Human Environment (Stockholm 1972) Stockholm Declaration Associated Instruments: - UN Environment Programme - UNEP Joint Group of Experts on the Scientific Aspects of Marine Environment Protection (GESAMP)	
1982	UN Convention on the Law of the Sea		
	Associated Instruments: - International Seabed Authority - Commission on Limits of the Continental Shelf - International Tribunal for the LOS - Meeting of the State of the Parties	UN Conference on Environment and Development (Rio de Janeiro 1992) Rio Declaration Convention on Biological Diversity Agenda 21 Associated Instruments: - CBD Conference of the Parties - CBD Jakarta Mandate - CBD Subsidiary Body on Scientific, Technical and Technological Advice - UN Sustainable Development Commission - World Bank Global Environmental Facility	Cancún Declaration
1992			FAO Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas
1995	UN Agreement Relating to Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks		FAO Code of Conduct for Responsible Fisheries
2001			Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem
2002		World Summit on Sustainable Development (Johannesburg 2002) Johannesburg Declaration Associated Instruments: - WSSD Implementation Plan	FAO Reykjavik Declaration

Figure 1 Time line showing the development of the three strands of global ocean governance policy drivers under the UN Law of the Sea (UNCLOS), the UN Conference on Environment and Development (UNCED) and the UN Food and Agricultural Organisation (FAO). Heavy outlined boxes indicate agreements which have a legal status once ratified.

of common marine resources and of common ecosystems. However, it was the UN process which has steered the development of international ocean governance and policy since its inception in 1945, and it is within the UN framework that international, regional and national marine ecosystem policies lie.

In a similar way to policy issues, international marine science and the scientific response to marine ecosystem policy drivers is being overseen

by the International Oceanographic Commission (IOC), itself part of the UN Education, Science and Cultural Organisation (UNESCO), an instrument also established in 1945 at the birth of the UN.

The following sections briefly outline the principal aspects of each of the three global ocean governance policy strands identified above. Emphasis is placed on aspects relevant to an “ecosystem approach” to fisheries management.

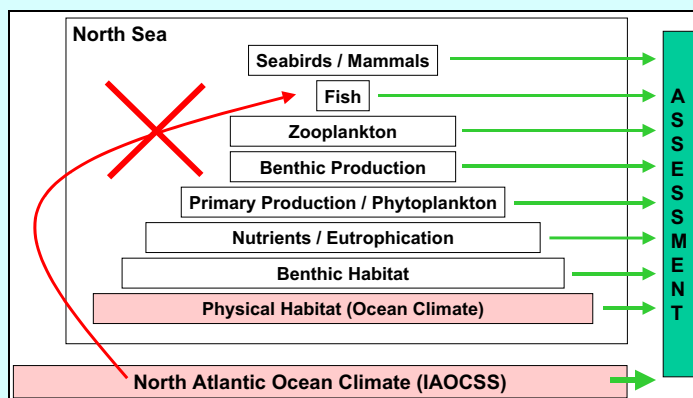
Table 1 *Emphasis on management and scientific concepts and tools arising within the different policy instruments, related to an “ecosystem approach” to fisheries management. Instruments: CLOS—UN Law of the Sea (1982), STRAD—UN Agreement on Straddling Stocks (1995), SCK’72—Stockholm Declaration (1972), RIO—Rio Declaration (1992), A21—Agenda 21 (1992), COP—Decisions of Conference of the Parties (CBD) (1992–2003), WSSD—World Summit on Sustainable Development (2002), CODE—FAO Code of Conduct (1995), REY—FAO Reykjavik Declaration (2001)*

	CLOS	STRAD	SCK’72	RIO	CBD	A21	COP	WSSD	CODE	REY
Conservation										
Biodiversity / Biological Diversity										
Habitats										
Ecosystems										
Fish Stocks										
Alien Species (prevention)										
Management Concepts										
Sustainable Use										
Integrated										
Stakeholder Involvement										
Environmental Factors										
Socio-economic Factors										
De-centralised										
Transparency										
Integrated Coastal Zone Management										
Climate Change										
Management Tools										
Precautionary Approach										
Maximum Sustainable Yield										
Long-term Management Plans										
National Action Plans										
Use of Traditional Knowledge										
Consider Species Interactions										
Restoration Plans										
Financial Incentives (to conserve)										
Scientific Tools										
Ecosystems Monitoring										
Indicators										
Environmental Impact Assessment										
Strategic Environmental Assessment										
Marine Protected Areas										
Status Reports (Baselines)										
Pilot Projects										
Selective Fishing Gear										
Ecosystem Models										
Other Concepts										
Need for Ecosystem Research										
Capacity Building										
Education Programs										
Data Release / Exchange										

Table 2 Details of ratification of global ocean policy instruments by ICES country (data given is as available from cited web sites as at February 2004)

	UNCLOS (1982)	Straddling Stocks (1995)	BDC Signed (1992)	BDC Ratified (1992)	Stockholm Declaration (1972)
Belgium	1998	2003	1992	1996	Y
Canada	2003	1999	1992	1992	Y
Denmark		2003	1992	1993	Y
Estonia			1992	1994	
Finland	1996	2003	1992	(1994)	Y
France	1996	2003	1992	1994	Y
Germany	1994	2003	1992	1993	Y
Iceland	1985	1997	1992	1994	Y
Ireland	1996	2003	1992	1996	Y
Lithuania	2003		1992	1996	
Netherlands	1996	2003	1992	(1994)	Y
Norway	1996	1996	1992	1993	Y
Poland	1998		1992	1996	
Portugal	1997	2003	1992	1993	Y
Russia	1997	1997	1992	1995	
Spain	1997	2003	1992	1993	Y
Sweden	1996	2003	1992	1993	Y
UK	1997	2003	1992	1994	Y
USA		1996	1992		Y
EU	1998	2003	1992	(1993)	

Towards Integrated Assessments

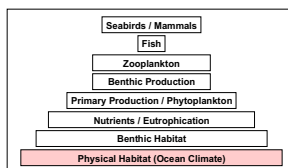


The above figure represents the different science branches needed to prepare an integrated assessment of the status of the North Sea ecosystem. The selection mirrors some of the science-based Working Groups available within ICES. Operational products from the physical oceanographic community, such as assessments of ocean climate, in many ways underpin assessments of the other trophic levels of the ecosystem. Presently, single-species stock assessments occur within the box marked "Fish". Physical oceanographers engaged in operational oceanography, and especially those engaged in assembling the description of annual conditions in the North Atlantic in the ICES Annual Ocean Climate Status Summary (IAOCSS), are often disheartened as the operational fish stock assessment currently performed within Europe does not use assessments of the ocean climate of a region. In fact, single-species assessments presently have no methodology to use ocean climate information. However, the direct link between ocean climate and

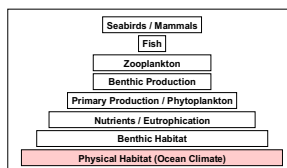
single-stock assessment is a spurious one. All science areas should be looking forward to supplying their information to integrated assessments. The ICES Regional Ecosystem Group for the North Sea (REGNS) is attempting to develop the techniques needed by integrated ecosystem assessments, and attempting to provide the green box in the figure above. (Here, an assessment is the collation, synthesis and interpretation of data, using summarising metrics and models, in order to describe status and trends, often in relation to reference points or levels, in a form that can be used to provide management advice).

While the example above focuses on the North Sea, integrated ecosystem assessments will be required for all eco-regions within the ICES area. In many ways the ICES Annual Ocean Climate Status Summary will underpin all these assessments, as it is the North Atlantic which sets the oceanographic context of most of our managed regions.

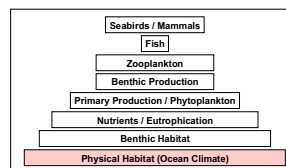
Scotian Shelf



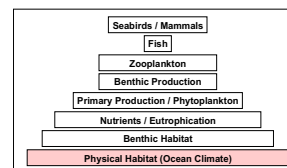
Norwegian Sea



Bay of Biscay



North Sea



North Atlantic Ocean Climate (IAOCSS)

5 The UNCLOS Process

This strand has been championed by many nations and individuals, and has been driven by the need of industries and Governments to exploit and manage the living and non-living resources of the oceans within a legal framework. Individuals such as the international civil servant and scholar Arvid Pardo established concepts such as “the deep-sea and its resources are a common heritage of mankind”. Pardo also formalised the idea that all aspects of “ocean space” are interrelated and should be treated as a whole—perhaps the first marine, scientific enunciation of an “ecosystem approach”.

The UN held conferences on the Law of the Sea in 1958 and 1960. The International Ocean Institute, led by Elisabeth Mann Borghese and acting under the auspices of the UNESCO, started the annual influential *Pacem in Maribus* Conferences in 1970, many focusing on Law of the Sea issues. At the same time, Regional Seas Conventions were being established, for example in the North Sea in 1974.

A lengthy drafting process ended in the signing by 117 nations of the UN Law of the Sea in 1982. Today, 144 countries are signatories.

5.1 United Nations Convention on the Law of the Sea (1982)

It could be argued that UNCLOS provides one of the principal legal frameworks within which most environmental and fishery assessment, management, enforcement and research presently operates in signatory states, including the European Union. UNCLOS has often been described as the “Constitution of the Oceans” and has a formal legal status, with instruments to enforce, arbitrate and implement the policies embodied within its statutes.

UNCLOS focuses on issues of resource utilisation and environmental protection, rather than on ecosystems, biodiversity or habitats. It consists of 320 articles and 9 annexes, and covers such topics as the establishment of territorial seas out to 12 nautical miles from the coast, Exclusive Economic Zones (EEZs) out to 200 nautical miles from coasts, the definition of a nation’s continental shelf, rights over the sea-bed and its resources, the right of passage through territorial and international

waters, including rights to carry out fishing, and the legal status of islands and archipelagos.

Text Box 1 summarises parts of UNCLOS with specific relevance to fisheries management. Management concepts that emerge from UNCLOS include taking into account target and non-target stock and species interactions, as well as relevant environmental and economic factors. Managers must preserve or restore stocks to their “maximum sustainable yield”. UNCLOS emphasises regional and sub-regional cooperation, as well as the need to base decisions on best scientific evidence. It requires signatories to collect and publish fishery statistics, as well as to undertake fishery research programmes. Signatories are also required to conserve and manage marine mammals, migratory stocks, and anadromous and catadromous species.

Articles on environmental pollution establish the concepts of Environmental Impact Assessments for activities potentially causing harm to the environment, as well as legislation covering dumping at sea and the introduction of new or alien species to a region. A section on marine research covers issues concerning research in other nations’ waters and in international waters, the deployment of buoys and moorings, and the need to undertake capacity building in developing countries. Signatories are obliged to publish the results of marine scientific research, including collected data.

In summary, UNCLOS permits States to exploit their marine resources within a legal framework, and in many ways embodies the principles of fisheries management before the “ecosystem approach” was conceived.

UNCLOS never refers to biodiversity (see Annex 1 for explanation of terms), and only mentions habitats or ecosystems once, in Article 194 (Measures to prevent, reduce and control pollution of the marine environment)—“The measures taken in accordance with this Part shall include those necessary to protect and preserve rare or fragile ecosystems as well as the habitat of depleted, threatened or endangered species and other forms of marine life”.

UNCLOS directly established five legal entities; the International Seabed Authority, a Commission to deal with the definition of national continental shelves, an International Tribunal to settle disputes,

Text Box 1: United Nations Convention on the Law of the Sea (1982)

- Coastal states should, in their EEZs and on the High Seas;
- maintain living resources and not endanger stocks by over-exploitation
 - ensure proper conservation and management measures
 - determine the allowable catch of the living resources in its EEZ, using best scientific evidence
 - maintain harvested populations at levels which can produce the maximum sustainable yield
 - take into account relevant environmental and economic factors
 - take into account the interdependence of stocks and species
 - restore depleted populations (target and non-target)
 - account for the economic needs of coastal fishing communities
 - account for traditional fishing patterns
 - use regional and sub-regional cooperation
 - share available scientific information, catch and fishing effort statistics

- Management will promote the optimum utilisation of living resources, without prejudice to conservation;
- by determining the species which may be caught
 - by fixing catch quotas
 - by licensing fishermen, fishing vessels and equipment
 - by regulating seasons and areas of fishing
 - by regulating the types, sizes and amount of gear
 - by regulating the types, sizes and number of fishing vessels
 - by fixing the age and size of fish and other species that may be caught
 - by giving other States access to any surplus of the allowable catch

States will minimise any economic effect on States whose nationals have habitually fished in their zone or which have made substantial efforts in research and identification of stocks

- States will specify information required of fishing vessels, including;
- catch statistics
 - effort statistics
 - vessel position reports

- States will conduct and regulate fisheries research programmes, which will include;
- the sampling of catches and the disposition of samples
 - the reporting of associated scientific data
 - the publication of information on proposed major programmes and their objectives
 - the publication of knowledge resulting from marine scientific research
 - the active promotion of the flow of scientific data and information
 - the active promotion of the transfer of knowledge resulting from marine scientific research

- States will take measures to;
- protect and preserve rare or fragile ecosystems
 - protect the habitat of depleted, threatened or endangered species and other forms of marine life
 - prevent the intentional or accidental introduction of species, alien or new

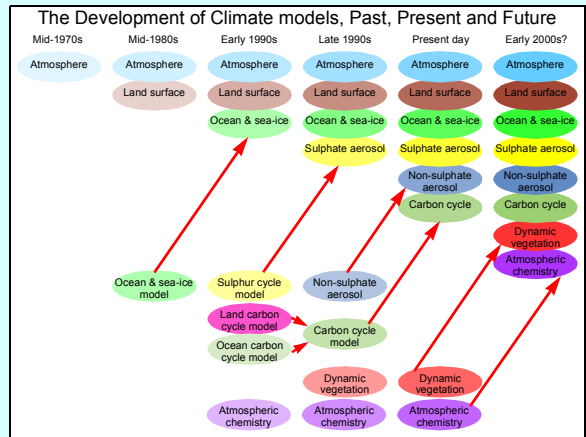
- States will, in relation to activities that may cause pollution or significant and harmful changes to the marine environment;
- observe, measure, evaluate and analyse the risks or effects of pollution of the marine environment
 - keep under surveillance the effects of any activities which they permit or in which they engage
 - assess the potential effects of such activities and publish the resulting assessment

States will provide capacity building, education and training for developing States

Note: Formal wording has been paraphrased throughout.

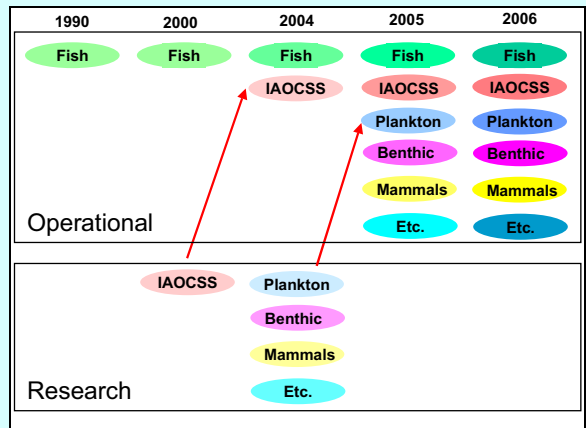
Progress Towards Ecosystem Models and Assessments

The atmospheric climate research and modelling community has gone through a process which can serve as an example to the marine science community, if we are to produce the tools needed for an "ecosystem approach" to fisheries and environmental management. Starting in the 1970s and 1980s (see figure below, courtesy of the Intergovernmental Panel on Climate Change, from the third report), models used to provide governments with advice about future climate change incorporated just a few physical mechanisms, such as atmospheric physics and the effect of land-use. However, at the same time "off-line" developments were occurring in ocean and sea-ice modelling. These improvements were incorporated into the "advisory" models in the 1990s, and off-line research focused on more refined processes such as sulphur and carbon cycles. Thus the community progressed towards improved and more sophisticated models, used to synthesise available data, arrive at predictions and develop model products in order to underpin advice.



A similar "model" of progress can be imagined towards the tools needed for an "ecosystem approach". In the 1990s, only single-stock fish assessments were available, using Virtual Population Analysis (VPA) models. However, ICES has been developing assessments of other aspects of the ecosystem "off-line", such as the ICES Annual Ocean Climate Status Summary (IAOCSS). This has now become operational, in the sense that it is produced in a regular, repeated manner each year. Other marine science areas are also developing operational assessment tools, covering phytoplankton, harmful algal blooms, zooplankton, benthic habitats, seabirds, and marine mammals. As each science community produces new assessment and modelling tools, they can become operational in support of an "ecosystem approach" to fisheries management. At the same time, each assessment strand itself can be enhanced, for example, with the incorporation of environmental parameters such as temperature into traditional VPA-type models.

If this method of progression is to work, it is the responsibility of organisations such as ICES, EuroGOOS and the European Commission to ensure co-ordination of funded science and operational application of that science. The results of funded research must be captured by investing our intellectual output into the improvement of selected models or systems, rather than an unfocused "scatter-gun" approach.



a framework for signatories to evolve UNCLOS (the Meeting of State of the Parties), and the UN Agreement on the Conservation and Management of Straddling Fish Stocks And Highly Migratory Fish Stocks. A sixth instrument, the establishment by signatories of national or international marine research centres to help developing countries, has not yet been implemented.

the natural resources they contain. Countries who have not yet ratified UNCLOS were encouraged to do so at the World Summit in Johannesburg, 2002.

5.2 Agreement Relating to the Conservation and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks (1995)

The objective of this Agreement was to ensure the long-term conservation and sustainable use of straddling fish stocks and highly migratory fish stocks, within territorial waters and throughout the high seas, through effective implementation of the relevant provisions of UNCLOS. The Agreement again focuses on “maximum sustainable yields”, multi-species interactions and the importance of best scientific evidence. It obliges signatories to employ the precautionary approach when managing migratory species, a concept UNCLOS itself does not use.

The Agreement also notes the potential impact natural events (which would include climate change) may have, and insists States should act on an emergency basis when such effects adversely impact a stock. It calls for the acknowledgement of traditional fisheries, transparent regional management practices, and the collection, exchange and publication of data. It calls for relevant oceanographic and ecological research to be carried out in order to augment stock assessment information. It also provides the legal framework for compliance and enforcement practices.

Unlike UNCLOS itself, the Straddling Stocks agreement notes the importance of preserving biodiversity, maintaining the integrity of marine ecosystems and minimising the risk of long-term or irreversible effects of fishing operations in its Preamble, and this is implemented in Article 5.

5.3 Present Status (2004)

The UNCLOS process continues to the present day, with new signatories joining, and the UNCLOS legal instruments making decisions to settle disputes. Many countries are presently surveying their EEZs in order to register their interests over

6 The UNCED Process

The UN Conferences on Environment and Development (UNCED) process leads through the major environment and sustainable development summits held by natural Heads of State and Ministers in order to direct action at major issues such as world poverty, the sustainable use of natural resources and environmental degradation. It involves an incredible, global scale level of commitment and work by scientists, administrators, concerned citizens and politicians. It is out of the UNCED process that the fundamentals of the “ecosystem approach” emerges.

6.1 Stockholm Declaration (1972)

The UN Conference on the Human Environment, held in Stockholm in 1972, in some ways marked the start of the UNCED process. In the initial proclamations contained in the Declaration of the Conference, signatories noted that the world was at a turning point at that time, and that man possessed the ability to impact the environment and ecosystems to an extent that was not possible before. However, the natural and the man-made aspects of the environment both contributed towards the most basic human right; the right to live. They noted that it was the desire of all the people of the world, and the duty of all Governments, to protect and improve the human environment. Harmful effects on the environment were already evident in many regions of the world, and the point had been reached when man had to shape its own actions in order to protect the environment.

Just as Arvid Pardo’s concepts provide a basic definition of an “ecosystem approach” from an ocean resource and a marine science perspective, the proclamations of the Stockholm Declaration suggest underlying concepts of an “ecosystem approach” from a sustainable development perspective; e.g. “The goal [to defend and improve the human environment for present and future generations] will demand the acceptance of responsibility by citizens and communities and by enterprises and institutions at every level, all sharing equitably in common efforts. Individuals in all walks of life as well as organisations in many fields, by their values and the sum of their actions, will shape the world environment of the future”. This statement underlines the principles of

integrated management and stakeholder involvement.

After these background concepts, the Declaration goes on to lay down 26 principles, which include many aspects of development, human rights, conservation of non-renewable resources, nuclear proliferation, capacity building, economics and poverty relief. However, It is worth reproducing some of the relevant wording of the Stockholm Declaration Principles as they form key-stone concepts which an “ecosystem approach” should be built upon (see Text Box 2).

For example, Principles 2, 3 and 4 underpin the concept of Marine Protected Areas, habitat restoration plans and nature conservation. Principle 13

Text Box 2: The Stockholm Declaration (1972)

- 1 Man bears a solemn responsibility to protect and improve the environment for present and future generations
- 2 The natural resources of the earth, and especially representative samples of natural ecosystems, must be safeguarded for the benefit of present and future generations through planning and management
- 3 The capacity of the earth to produce vital renewable resources must be maintained, restored or improved
- 4 Man has a responsibility to safeguard and manage the heritage of wildlife and its habitat, which are imperilled by a combination of adverse factors. Nature conservation, including wildlife, must receive importance in planning for economic development
- 6 The discharge of toxic substances, that exceed the capacity of the environment to render them harmless, must be halted in order to protect ecosystems
- 7 States shall take all possible steps to prevent pollution of the seas by substances that are liable to create hazards to human health, to harm living resources and marine life, to damage amenities or to interfere with other legitimate uses of the sea
- 12 Resources should be made available to preserve and improve the environment
- 13 In order to achieve a more rational management of resources and thus to improve the environment, States should adopt an integrated and co-ordinated approach to their development planning so as to ensure that development is compatible with the need to protect and improve environment for the benefit of their population
- 14 Rational planning provides the tool to reconcile any conflict between the needs of development and the need to protect and improve the environment
- 18 Science and technology must be applied to the identification, avoidance and control of environmental risks and the solution of environmental problems
- 19 Education in environmental matters is essential in order to broaden the basis of responsible conduct by individuals, enterprises and communities in protecting and improving the environment
- 20 The free flow of up-to-date scientific information and transfer of experience must be supported and assisted, to facilitate the solution of environmental problems
- 21 States have the right to exploit their own resources pursuant to their own environmental policies, and the responsibility to ensure that activities within their control do not cause damage to the environment beyond the limits of national jurisdiction

Note: Formal wording has been paraphrased in places.

encapsulates the concept of an integrated, holistic approach to ecosystem management “in order to achieve a more rational management of resources and thus to improve the environment”, and hence lies at the heart of an “ecosystem approach”. Principles 13 and 14 underpin the development and use of management plans.

Principle 18 provides the framework for scientific monitoring, assessment and modelling of ecosystems. Principles 19 and 20 underpin capacity building, environmental education requirements and stakeholder involvement. Principles 3 and 21 underpin sustainable use and maximum sustainable yield.

Principle 6 acknowledges that the environment can be used for waste disposal, but not beyond its capacity to absorb waste without ill effect. Additional Principles outline the “polluter pays” concept, which has been incorporated into many regional marine policies and which appears in later global ocean policy drivers. They also go on to emphasise the need for international cooperation in order to tackle environmental issues.

The Stockholm Conference directly led to the creation of the UN Environment Programme (UNEP), which has steered much of the UNCED process since then.

6.2 Preparations for Rio

In the decade that followed the Stockholm Declaration, most developing countries put into place the institutions and legislation needed to carry through the Stockholm Principles. However, in the developing world it was noted that poverty and underdevelopment hindered progress (Haas *et al.*, 1992). In addition, interpretation of the Stockholm Declaration differed widely between nations. In the 1980s, the UN established the World Commission on Environment and Development (also known as the Brundtland Commission), which wrote the Brundtland Report, entitled “Our Common Future”. This established much of the philosophy behind the Rio Declaration and Agenda 21. In 1987 the UN General Assembly called for a harmonising Conference, which would address the combined issues of environmental protection and sustainable development; the UN Conference on Environment and Development (UNCED).

Prior to the Conference, which was to be held in Rio de Janeiro, Brazil, in June 1992, there were 5 organising and preparatory meetings to draft the documents that would be signed by Heads of State

and Ministers at the end of the Conference itself. Progress was slow, and most of the Rio Declaration and Agenda 21 was agreed at the very last preparatory meeting, termed the “New York Marathon”. Two other environmental conventions were prepared by separate processes, the Convention on Climate Change and the Convention on Biological Diversity, but these were also signed at the Rio “Earth Summit” along with the Rio Declaration and Agenda 21. Veterans from the Stockholm meeting, and from the UN Law of the Sea process were appointed to key positions in UNCED, ensuring a degree of continuity between the different processes.

There now follows brief descriptions of the Rio Declaration, the UN Convention on Biological Diversity, and Agenda 21.

6.3 Rio Declaration (1992)

The Rio Declaration itself is a simple document of 27 short Principles. It starts by reaffirming the Stockholm Declaration, and calls for the establishment of a new “global partnership” to work towards protecting the integrity of the global environment and developmental system through international agreements.

The introductory affirmation, that signatories recognise “the integral and interdependent nature of the Earth, our home”, expands on Pardo’s earlier concept expressed in relation to the oceans. The Principles state in simple terms the fundamental concepts of the human need for a healthy relationship with nature, the right to exploit resources, and the right to develop while at the same time taking care of the environment. Poverty reduction, capacity-building, environmental legislation, and trade policy are outlined. Issues such as compensation for victims of pollution and waste “trading” between States are dealt with, and the “polluter pays” principle is restated. Other issues raised are the role of women, young people and indigenous people in sustainable development.

The Declaration itself reaffirms the principles of the Stockholm Declaration in aspects relevant to an “ecosystem approach” to fisheries and environmental management (see Text Box 3). Principle 10, in particular, emphasises the need for stakeholder involvement in an open and transparent decision-making process. It also clearly expresses the fundamental right for citizens to access to all environmental data generated by government. The Declaration reasserts the need for a precautionary approach, which includes the concept that a lack of

scientific knowledge must not be used as an excuse not to take management decisions. This emphasises the need for marine scientists to provide advice using the tools we presently have, and not dodge the issue by perpetually waiting until further research is carried out. Environmental Impact Assessments are introduced as a tool for environmental management. Tools such as Ecological Quality Objectives (EcoQOs) are suggested by Principle 11.

6.4 UN Convention on Biological Diversity (1992)

The Convention on Biological Diversity (CBD) does not discriminate between terrestrial or marine biological diversity, but treats all equally. The Convention commences by acknowledging the intrinsic value of biological diversity to mankind, that its conservation is a common concern of humanity, that it is being eroded by man's activity and that a lack of scientific certainty should not prevent any action needed to conserve biological diversity. The 42 Articles of the CBD go on to define its three principle objectives; the conservation of biological diversity, the sustainable use of

its components, and the fair and equitable sharing of its benefits.

In relation to an "ecosystem approach" (see Text Box 4), the CBD calls for cross-sectoral, integrated management and planning, involving stakeholders and the private sector (Principles 6 and 10). Increased emphasis (compared to the Stockholm Declaration) is placed on tools for an "ecosystem

Text Box 3: The Rio Declaration (1992)

- 4 In order to achieve sustainable development, environmental protection shall constitute an integral part of the development process and cannot be considered in isolation from it
- 7 States shall cooperate to conserve, protect and restore the health and integrity of the Earth's ecosystem
- 8 States should reduce and eliminate unsustainable patterns of production
- 10 Environmental issues are best handled with the participation of all concerned citizens, at the relevant level. At the national level, each individual shall have appropriate access to information concerning the environment that is held by public authorities, including information on hazardous materials and activities in their communities, and the opportunity to participate in decision-making processes. States shall facilitate and encourage public awareness and participation by making information widely available. Effective access to judicial and administrative proceedings, including redress and remedy, shall be provided
- 11 States shall enact effective environmental legislation. Environmental standards, management objectives and priorities should reflect the environmental and developmental context to which they apply
- 15 In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation
- 17 Environmental impact assessment, as a national instrument, shall be undertaken for proposed activities that are likely to have a significant adverse impact on the environment and are subject to a decision of a competent national authority
- 22 Indigenous people and their communities and other local communities have a vital role in environmental management and development because of their knowledge and traditional practices. States should enable their effective participation in the achievement of sustainable development

Note: Formal wording has been paraphrased in places.

Text Box 4: The Convention on Biological Diversity (1992)

Contracting Parties shall;

- 6 - develop national strategies for the conservation and sustainable use of biological diversity
 - integrate the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral policies
- 7 - identify components of biological diversity important for its conservation and sustainable use and monitor these through sampling and other techniques
 - pay particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use
 - identify activities which are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects
 - maintain and organise, by any mechanism data, derived from identification and monitoring
- 8 - establish a system of protected areas or areas where special measures need to be taken to conserve biological diversity
 - promote the protection of ecosystems, natural habitats and the maintenance of viable populations of species in natural surroundings
 - rehabilitate and restore degraded ecosystems and promote the recovery of threatened species through the development and implementation of plans or other management strategies
 - develop legislation for the protection of threatened species and populations
- 10 - integrate consideration of the conservation and sustainable use of biological resources into national decision-making
 - support local populations to develop and implement remedial action in degraded areas where biological diversity has been reduced
 - encourage cooperation between its governmental authorities and its private sector in developing methods for sustainable use of biological resources
- 11 - adopt economically and socially sound measures that act as incentives for the conservation and sustainable use of components of biological diversity
- 12 - maintain programmes for scientific and technical research, education and training in measures for the identification, conservation and sustainable use of biological diversity
- 13 - promote the understanding of the importance of, and the measures required for, the conservation of biological diversity, through the media, and the inclusion of these topics in educational programmes
 - develop educational and public awareness programmes, with respect to conservation and sustainable use of biological diversity
- 14 - require environmental impact assessment of proposed projects that are likely to have significant adverse effects on biological diversity with a view to avoiding or minimising such effects and, where appropriate, allow for public participation in such procedures
- 17 - exchange information, from all publicly available sources, relevant to the conservation and sustainable use of biological diversity
 - this shall include exchange of results of technical, scientific and socio-economic research, as well as information on training and surveying programmes, specialised knowledge, indigenous and traditional knowledge

Note: Formal wording has been paraphrased in places.

approach”, including monitoring and the storage, use and dissemination of monitoring data (P7), Marine Protected Areas and restoration plans (P8), and Environmental Impact Assessments (P14).

Other issues covered by the CBD include the use of the genetic resource represented by biological diversity, technology transfer, data exchange, scientific cooperation, dealing with the emerging biotechnology issues, and a requirement that States should put in place funding for all of the necessary conservation activities.

The Convention established a Conference of Parties (COP) to take the Convention forward, as well as a supporting Secretariat. The COP has met six times between 1994 and 2002. As will be seen below, decisions taken at the COP should be viewed as fundamental in the development of an “ecosystem approach”.

6.5 Agenda 21 (1992)

Agenda 21 is an “Action Plan” of global scale, designed to implement the Conventions signed at the Rio Summit, and in particular the Rio Declaration. It is a vast document, of some 40 chapters, covering all the aspects of environment and sustainable development identified by the Declaration itself. Each subject chapter goes into considerable detail concerning how States may work towards improvements. For each programme area, chapters identify the reasons why action is needed in that area, the objectives States should adopt, and the necessary related activities and the means of implementing these activities. Activities are separated into those related to management, to data and information exchange and to international cooperation. Each chapter also has estimates of potential costs of the actions suggested. Hence the importance of clear objectives, management policies, and information gathering and exchange is emphasised from the start.

Although environmental issues are integrated throughout all chapters, chapters directly related to an “ecosystem approach” to fisheries management are Chapters 15 (protection of biodiversity), 17 (protection of the oceans) and 32 (role of fishers and farmers). It may be noted that, at about 30 pages each, the chapters on the oceans and on freshwater are each twice as long as any other chapter, possibly indicating the complexity of these subjects, as well as the already existing substantial policy frameworks in these areas.

6.6 Agenda 21—Biodiversity

Relevant objectives aimed at protecting biodiversity are outlined in Text Box 5. As with the CBD, increasing emphasis is placed on the tools needed for an “ecosystem approach”. For example, several objectives can be seen to lead towards ecosystem indicators and ecosystem status reports, as Governments are instructed to develop methodologies for the systematic sampling and evaluation of the components of biodiversity, and to establish baseline information on biological and genetic resources in marine ecosystems. Governments are required to make available the information from ecosystem status assessments in a timely manner, and in a form suitable for decision-making. Specific reference is also made to Marine Protected Areas and Environmental Impact Assessments.

6.7 Agenda 21—the Oceans

Chapter 17 focuses on seven key programme areas needed to protect the oceans:

- integrated management and sustainable development of coastal areas and the EEZ
- marine environmental protection
- sustainable use and conservation of marine living resources of the high seas

Text Box 5: Agenda 21—Protecting Biodiversity

States, in cooperation with regional organisations as well as the private sector, should;

- develop national strategies for the conservation of biological diversity and the sustainable use of biological resources
- integrate sustainable use of biological resources into national development strategies
- carry out national studies on
 - the conservation of biological diversity
 - the sustainable use of biological resources
 - the associated costs and benefits, and socio-economic aspects
- develop methodologies for the systematic sampling and evaluation of the components of biological diversity and the status of ecosystems
- establish baseline information on biological and genetic resources in marine ecosystems
- make available ecosystem status information
 - in a timely manner
 - in a form suitable for decision-making
- undertake long-term research into
 - the importance of biodiversity for the functioning of ecosystems
 - the role of ecosystems in producing goods and environmental services
- use
 - Environmental Impact Assessments to assess activities impacting biodiversity
 - Marine Protected Areas to protect biodiversity
- carry out education on biodiversity issues

- sustainable use and conservation of marine living resources under national jurisdiction
- addressing critical uncertainties for the management of the marine environment and climate change
- strengthening international, including regional, cooperation and co-ordination
- the sustainable development of small islands

The chapter stresses from the outset that these programme areas require “new approaches to marine and coastal area management and development, at the national, sub-regional, regional and global levels, approaches that are integrated in content and are precautionary and anticipatory in ambit”. This statement seems to emphasise that an “ecosystem approach” will require fundamental changes in the management practices that existed at that time.

The section on integrated management of coastal areas and the EEZ (see Text Box 6) emphasises the need of integrated policy and decision-making processes, based on a broad range of scientific tools, and involving consultation with the business community, academic sector, resource user groups, and the general public. The tools identified include assessment databases of relevant socio-economic and environmental criteria.

The section on environmental protection defines in some detail how states may achieve the objectives of using preventive, precautionary and anticipatory approaches to avoid degradation of the marine environment, the use of Environmental Impact

Text Box 6: Agenda 21—Integrated Management of Coastal Areas and the EEZ

Coastal states are required to;

- conserve and restore critical coastal and marine habitats
- provide an integrated policy and decision-making process which
 - promotes compatibility and a balance of uses in the coastal zone and EEZ
 - includes all involved sectors
 - uses the precautionary approach
 - uses Environmental Impact Assessments and environmental accounting
 - uses regular environmental assessment of coastal and marine areas
- consult with all sectors (business community, academic sector, resource user groups, the general public)
- maintain assessment databases of coastal areas, the EEZ and their resources
 - to develop socio-economic and environmental indicators
 - to develop relevant environmental quality criteria
- freely exchange all relevant data
- engage in capacity-building at a local level
- support “centres of excellence” in integrated coastal and marine resource management
- develop scientific research

Assessments, the integration of the protection of the marine environment into relevant general environmental, social and economic development policies, and the use of the “polluter pays” principle.

The sections on fisheries within the EEZ and within the High Seas reaffirms the commitments made within the UNCLOS process. Agenda 21 (see Text Box 7) refers to maintaining or restoring stocks to maximum sustainable yield. It also refers to the role science can play in resource management, through the development of modelling tools and the use of monitoring and assessment data.

The section focusing on uncertainties for the management of the marine environment introduces important concepts concerning climate change and its impacts for the first time in global ocean governance documents. States are required to co-ordinate observation programmes of coastal phenomena related to climate change, and attempt to provide improved forecasts of marine conditions. States are advised to implement ocean climate monitoring through UNEP, the IOC and GOOS. They are also required to organise periodic assessments of oceanic, shelf and coastal area status and trends in order to monitor climate change in the marine environment.

Text Box 7: Agenda 21—Living Marine Resources

Coastal States are required to

- develop and increase the potential of marine living resources
- maintain or restore populations of marine species to their maximum sustainable yield, taking into account relevant environmental and economic factors, and relationships among species
- reduce waste through discards
- ensure effective monitoring and enforcement with respect to fishing activities
- protect and restore endangered marine species, preserve habitats and other ecologically sensitive areas
- promote
 - scientific research with respect to marine living resources
 - the development and use of selective fishing gear
 - development and sharing of
 - analytical and predictive tools
 - stock assessment models
 - bio-economic models
 - appropriate monitoring and assessment programmes
 - collection and exchange of data on marine living resources
- develop Marine Protected Areas, with special focus on
 - reef ecosystems
 - estuaries
 - spawning areas
 - nursery areas.

6.8 Agenda 21—the Role of Stakeholders

Although the description above has picked out the parts of Agenda 21 focusing on the tools of an “ecosystem approach”, throughout Agenda 21 the original concepts of integrated, inclusive management are also echoed. In particular, the Chapter on the role of fishers (referred to as farmers by Agenda 21) reasserts the role of stakeholders in a decentralised decision-making process, involving local communities with economic incentives to manage the resources they exploit (see Text Box 8). As well as incentives, users of a resource must also bear the economic costs of environmental concerns arising from their exploitation of a resource.

6.9 After the Rio Summit

The Rio Summit spawned a number of international institutions designed to monitor progress on the conventions. For example, the UN Sustainable Development Commission was established, in part, to monitor progress towards the environmental

Text Box 8: Agenda 21—Involvement of Fishers

Rural activities

- take place in close contact with nature
- add value by producing renewable resources
- rely on resources vulnerable to over-exploitation and improper management

The key to the attainment of sustainability lies in

- a fisher-centred approach
- the motivation and attitudes of individual fishers
- government policies providing incentives to fishers to manage their natural resources efficiently and in a sustainable way

The decentralisation of decision-making towards local and community organisations is the key in changing people's behaviour and implementing sustainable fishing strategies.

The following objectives are proposed

- To encourage a decentralised decision-making process through
 - the creation and strengthening of local organisations
 - the delegation of power and responsibility to primary users of natural resources
- To promote and encourage sustainable fishing practices and technologies
- To introduce or strengthen policies that would;
 - encourage self-sufficiency in low-input and low-energy technologies
 - include indigenous practices
 - include pricing mechanisms that internalise environmental costs
- To develop a policy framework that provides incentives and motivation among fishers for sustainable and efficient fishing practices
- To enhance the participation of fishers, men and women, in the design and implementation of policies directed towards these ends, through their representative organisations.

Note: As Agenda 21 stipulates, here the terms fisher and fishing have replaced farmer and farming

goals of Agenda 21, and the Jakarta Mandate was established to implement the Convention on Biological Diversity. The requirement for national reporting of progress in environmental areas was another outcome of the summit, as well as commitments about the level of aid the developed nations would provide to under-developed regions. The cost of the full implementation of Agenda 21 was estimated at the time to be in the region of \$600 billion per year (Haas *et al.*, 1992). The World Bank was identified as the primary mechanism to direct national development funding. The World Bank in turn channelled funding to environmental activity through its Global Environment Facility (GEF), which initially had part of its focus directed towards biodiversity and international waters. Another outcome of the Summit was the increased role, networking, education and sophistication of NGOs who, in several policy areas, play a real role in surveillance, monitoring, reporting and management.

6.10 The “Ecosystem Approach”

Although, in reference to marine management, Agenda 21 refers to “new approaches”, “preventive, precautionary and anticipatory approaches”, “comprehensive approaches”, “multi-species management and other approaches”, “integrated management approaches”, “broad and coherent approaches”, “integrated and multi-sectoral approaches”, and “fisher-centred approaches”, it never actually uses the term “ecosystem approach”. This term is first used in decisions of the Conference of the Parties (COP) of the Convention on Biological Diversity, and in advice from its Subsidiary Body on Scientific, Technical and Technological Advice (SBSTTA), itself helped and supported by UNESCO.

Decision II/8, adopted by the second meeting of the COP in Jakarta in 1995, asserts “that the conservation and sustainable use of biological diversity and its components should be addressed in a holistic manner, taking into account the three levels of biological diversity [genetic diversity, species diversity, ecosystem diversity] and fully considering socio-economic and cultural factors. The ecosystem approach should be the primary framework of action to be taken under the Convention and in the implementation of its objectives”.

Decision II/10 (Annex 1) of the Jakarta COP, states that “the present mono-species approach to modelling and assessment should be augmented by

an ecosystem process-oriented approach, based on research of ecosystem processes and functions, with an emphasis on identifying ecologically critical processes that consider the spatial dimension of these processes. Models of ecosystem processes should be developed through trans-disciplinary scientific groups (ecologists, oceanographers, economists, and fisheries experts) and be applied in the development of sustainable land and coastal resource use practices.”

These decisions placed an “ecosystem approach” at the heart of the implementation of the Convention on Biological Diversity, in terrestrial, freshwater and marine habitats. They also begin to clarify what an “ecosystem approach” is. However, from these decisions it obviously is meant to be somewhat schizophrenic, having two components; one creating the policy framework to implement conservation and sustainable use, and one related to multi-disciplinary science and the development of scientific tools.

The call to Governments to implement an “ecosystem approach” is repeated in numerous further COP Decisions, and especially by COP Decision V-6 (2001). This Decision contains an annex, based on the report of a workshop held in Malawi in 1998, which outlines the CBD definition, twelve guiding principles and five operating principles of an “ecosystem approach”. These are included in Annex 2 below.

In summary, the CBD definition contains advice with respect to both the scientific content, as well as the managerial policy content, of an “ecosystem approach”. Scientifically, the COP advises that an “ecosystem approach” should focus on ecosystem function, and should also be constructed over the appropriate space scale, which in itself may not be set by ecosystem characteristics but by operational needs of users and managers. Key concepts for management are to be adaptive, integrated, cross-sectoral, inclusive, de-centralised, science-based, and balanced (between conservation and use).

Decision V-6 also introduces a new tool of the “ecosystem approach”, the pilot project. The decision requests national Governments and regional bodies to undertake case-studies and “pilot projects” in order to develop and share experiences of the application of the “ecosystem approach”.

6.11 Ecosystem Indicators

It is also in COP Decisions that reference to the use of ecosystem indicators is first formalised, at least

with respect to global ocean policy drivers, and the UNCED process. COP Decision IV/1A (1998) called for the development of a set of principles for designing national-level monitoring programmes and indicators covering the ecosystem, species and genetic levels useful for national reporting of changes in biodiversity. Decision VI/7 (2001) expands on this call, and defines the use of indicators in Environmental Impact Assessments, and Strategic Environmental Assessments, which are required for activities which will impact biodiversity. The screening criteria, presented in the COP Decisions, for activities requiring these impact assessments would certainly require assessments to be carried out for fishing activities.

Work on indicators continued with an expert meeting on indicators of biological diversity which published an 85 page report on ecosystem indicators, their design and use, in 2003. The report contains a table listing 89 major web sites, each containing information on national or international biodiversity indicators.

Thus it can be seen that the relatively simple concepts expounded in the Rio Declaration (1262 words) and the CBD (10000 words) immediately generated a vast “industry” attempting to formulate the tools needed to implement the desires expressed in these conventions. For example, Agenda 21, which is the implementation plan arising from the conventions, runs to 149000 words, and the COP Decisions, which begin to formulate the tools needed for the implementation, consists of 230000 words (COP 1 to 6).

6.12 Jakarta Mandate (1995)

Arising from the various COP decisions described above was a program of action designed to implement the CBD, referred to as the “Jakarta Mandate on Marine and Coastal Biological Diversity”. The COP Jakarta meeting was held in 1995, and the associated program of work was adopted in 1998. It focuses on five main areas; implementation of integrated marine and coastal area management (IMCAM), marine and coastal living resources, marine and coastal protected areas, mariculture and alien species and genotypes. The first operational objective of the work programme area considering living resources is to promote “ecosystem approaches to [their] sustainable use”. The Jakarta Mandate operates within the COP/SBSTTA framework, with collaborations with organisations such as UNESCO.

6.13 World Summit on Sustainable Development (2002)

Progress towards the international implementation of Agenda 21 was monitored by such meetings as Rio+5 (New York, 1997). Most concern was expressed relating to poverty relief and capacity building in developing countries, as world poverty deepened after Rio. However, it was also noted that environmental degradation, as well as the depletion of fisheries, also continued after the signing of Agenda 21. Preparatory meetings commenced in 2001 leading up to the Rio+10 review; the World Summit on Sustainable Development (WSSD), held in Johannesburg in 2002. Numerous reviews were conducted during the preparation phase, including UNEP's Global Environment Outlook.

The WSSD had the objective of strengthening national commitments to Agenda 21, and biodiversity and ecosystem management was identified as one of 5 key issues for the Summit. UN studies presented prior to the Summit had demonstrated that 75% of world fisheries were exploited beyond their maximum sustainable yield. The agreements reached at WSSD relevant to fisheries management were that Governments committed action to:

- significantly reduce the loss of biodiversity by 2010
- restore fisheries to their maximum sustainable yields by 2015 and prevent, deter and eliminate illegal, unreported and unregulated fishing by 2004
- establish a representative network of Marine Protected Areas by 2012
- undertake initiatives by 2004 to implement the Global Programme of Action for the Protection of the Marine Environment from Land Based Sources of Pollution

The WSSD Implementation Plan (see Text Box 9), explicitly reasserts the central function of the "ecosystem approach", for which it refers specifically to COP Decision V/6 and the FAO Reykjavik Declaration (see below). It particularly emphasises the policy-related aspects of an "ecosystem approach", calling for integrated, multi-sectoral marine management, including the co-ordination between fisheries and environmental managers. Some of the multi-disciplinary scientific tools the Implementation Plan calls for are MPAs, EIAs, the precautionary approach, ICZM, nursery and spawning area closures, and national and international ecosystem status reports. The plan explicitly calls for more fundamental research into marine

ecosystem processes, as well as the improvement of ocean observing systems.

Another outcome from the WSSD was a series of Government/NGO/private sector partnerships which were attempting to implement the desire of Agenda 21 to involve stakeholders. Twenty-two of these were in the oceans / fishery sector, covering

Text Box 9: WSSD Implementation Plan (2002)

Encourage the application by 2010 of the ecosystem approach, noting;

- the Reykjavik Declaration on Responsible Fisheries in the Marine Ecosystem
- decision V/6 of the Conference of Parties to the Convention on Biological Diversity

Promote integrated, multidisciplinary and multi-sectoral coastal and ocean management at the national level, and encourage integrated coastal management

Strengthen cooperation and co-ordination between regional fisheries management organisations and other regional science, health and development organisations

Maintain or restore stocks to levels that can produce the maximum sustainable yield by 2015

Promote the conservation and management of the oceans through;

- maintaining the productivity and biodiversity of important and vulnerable marine and coastal areas
- developing diverse approaches and tools, including;
 - the ecosystem approach
 - the elimination of destructive fishing practices
 - the establishment of marine protected areas based on scientific information, including representative networks by 2012
 - time/area closures for the protection of nursery grounds and periods
 - proper coastal land use and watershed planning and the integration of marine and coastal areas management into key sectors
- developing national, regional and international programmes for halting the loss of marine biodiversity, including in coral reefs and wetlands
- regional programmes of action for the sustainable development of coastal and marine resources, noting in particular areas that are subject to accelerated environmental changes and development pressures

Improve the scientific understanding and assessment of marine and coastal ecosystems as a fundamental basis for sound decision-making, through actions at all levels to;

- increase scientific and technical collaboration
- facilitate integrated assessment at the global and regional levels
- expand ocean observing capabilities for the timely prediction and assessment of the state of marine environment

Establish by 2004 a regular UN process for global reporting and assessment of the state of the marine environment, including socio-economic aspects, building on regional assessments

Strengthen the ability of the IOC and FAO to build national and local capacity in marine science and the sustainable management of oceans and their resources.

Develop an integrated, multi-hazard, inclusive approach to address vulnerability, risk assessment and disaster management, including prevention, mitigation, preparedness, response and recovery

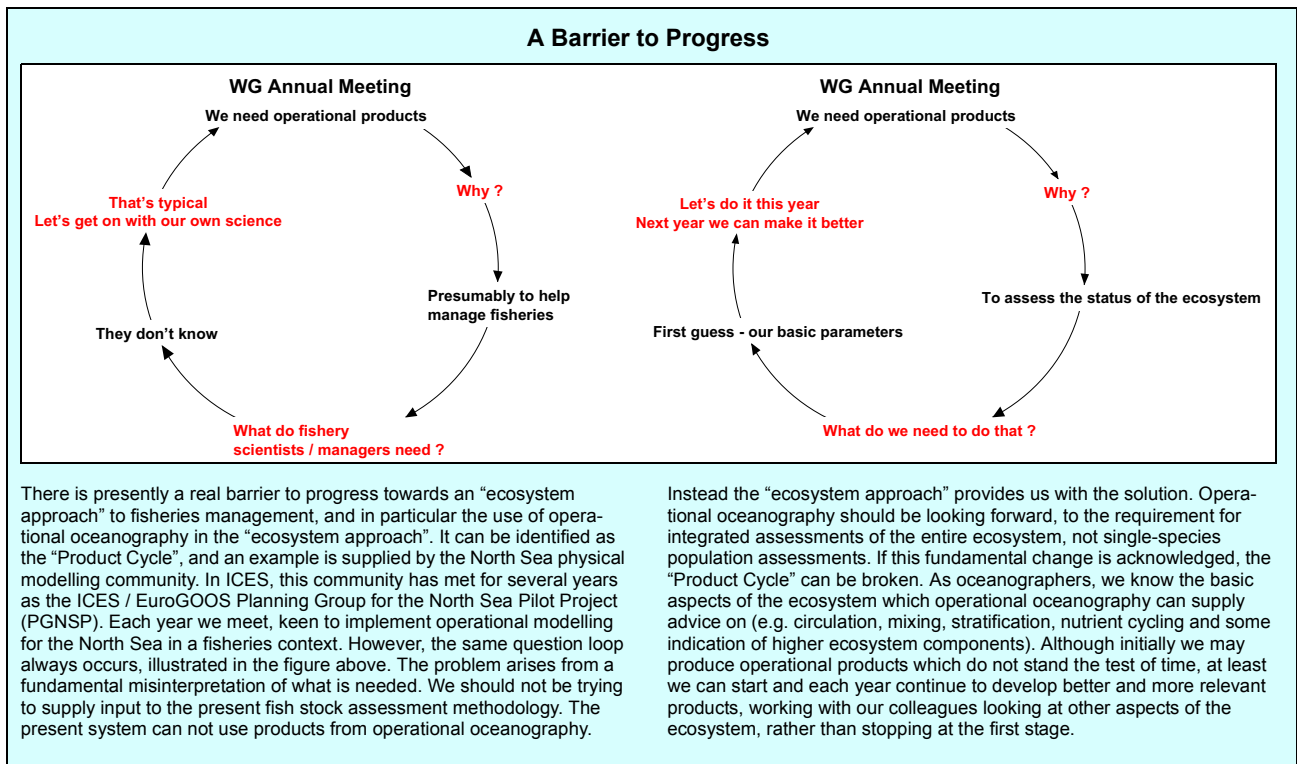
Ratify/implement UNCLOS, Straddling Stocks and High Seas Compliance Agreements, FAO Code of Conduct for Responsible Fisheries, FAO international plans of action, the Jakarta Mandate, Chapter 17 Agenda 21, Ramsar Convention, International Coral Reef Initiative, Global Programme of Action for the Protection of the Marine Environment from Land-based Activities, Montreal Declaration on the Protection of the Marine Environment from Land-based Activities.

topics such as coastal and catchment area integrated management, monitoring techniques for harmful algal blooms, ballast water management, coral reefs and fisheries, a high seas biodiversity workshop, coastal ecosystem management, as well as the IOC sponsored programmes POGO and GODAE.

The Johannesburg Declaration itself contains 37 Articles which make rather general, wide ranging points with no new message specifically in relation to an “ecosystem approach” to marine management.

6.14 Present Status (2004)

UN organisations such as UNEP, UNSDC and UNESCO are taking forward the CBD, the Rio Declaration, Agenda 21 and the WSSD decisions. The seventh meeting of the Conference of Parties of the CBD took place in 2004 in Malaysia, with a new emphasis on biosafety. The SBSTTA continues to work towards defining scientific tools needed by the “ecosystem approach”.



7 The FAO Process

The Food and Agriculture Organisation of the UN (FAO) was established in 1945, at the outset of the UN itself, in order to raise levels of nutrition and standards of living, improve agricultural production, and to better the conditions of rural populations. The FAO established a Committee on Fisheries in 1965. In 1991 concerns arising from over-fishing in many regions of the world's oceans, including within territorial waters, within EEZs and on the high seas, prompted a call for the development of new concepts which would lead to responsible and sustained fisheries. An FAO conference in Cancun (Mexico) in 1992 made a further call to the FAO to prepare an international Code of Conduct to address these concerns. In 1993, the Agreement to Promote Compliance with International Conservation and Management Measures by Fishing Vessels on the High Seas, which focused on enforcement and compliance, was adopted at the annual FAO Conference.

Then in 1995, after much technical discussions and consultations, the FAO unanimously adopted the Code of Responsible Fisheries as a non-mandatory guide. The guide outlined how all concerned with fisheries could work in such a way that they fulfilled all other legal obligations, as well as ensuring the sustainable exploitation of aquatic living resources, and ensuring such exploitation was in harmony with environmental concerns. The title of "responsible fisheries" itself echoes Principle 19 of the Stockholm Declaration (see Text Box 2), and the content of the Code emphasises many concepts of sustainable exploitation with environmental concern originating from the UNCED process.

7.1 FAO Code of Conduct for Responsible Fisheries (1995)

The 12 Articles of the Code focus on the nature, scope and objectives of the Code, its relationship with other international instruments, how the Code can be implemented, monitored and updated, special requirements of developing countries, and outlines the general principles of the Code. Specific sectors the Code addresses are fisheries management, fishing operations, aquaculture, integration of fisheries into coastal area management, post-harvest practices and trade and fisheries research.

The Code is voluntary, but includes aspects of UNCLOS and other legal instruments. It applies to all sectors associated with fishing, including

Text Box 10: The FAO Code of Conduct for Responsible Fisheries (1995)

The Code's general principles state that

- the right to fish carries with it the obligation to ensure conservation and management of the ecosystem
- sustainable exploitation should be managed not just with reference to target species, but also to non-target species and associated ecosystems
- States should prevent over-fishing and over-capacity, pollution and waste, and match fishing effort to the available resource
- assessments must be made of
 - the condition (size and productivity) of a stock relative to reference points
 - levels and distribution of mortality
 - impact of a fishery on non-target species
 - discards
 - relevant environmental factors
 - relevant socio-economic factors
- action must be taken when limit reference points are exceeded. The absence of scientific evidence should not prevent management actions being taken
- conservation and management decisions should
 - be based on best scientific evidence
 - take account of traditional knowledge
 - take account of relevant environmental and economic factors
 - be transparent and timely
 - involve industry and environmental organisation participation
 - avoid conflict between different users
 - be set within long-term management objectives and plans
 - use cost-benefit analyses to assess management options
 - be based on scientifically defined "whole stock" biological units
 - use the precautionary principle
- depleted populations must be restored as far as appropriate depending on existing conditions
- fishery management should be incorporated in Integrated Coastal Zone Management (ICZM), which should include;
 - CZ monitoring (physical, biological, chemical, economic, social)
 - promotion of public awareness of ICZM
 - protection of nursery areas, inshore habitats, wetlands and reefs
- States should develop fishing gear and fishing practices which;
 - maintain biological diversity and conserve the ecosystem
 - minimise waste and by-catch
 - minimise the effect on the environment
- conservation measures should be enforced, with compliance surveillance, and fishing vessel activity monitoring
- fishery statistics should be collected and published
- research should be carried out into biology, ecology, technology, environmental science, economics, social science, aquaculture and nutrition in relation to fish stocks, fisheries and fish products
- research results should be analysed and published in a timely and easily understood way

governmental and non-governmental organisations involved in fisheries development, conservation and management, fishers and workers in aquaculture, fish processors, fish farmers, fisheries scientists and coastal area managers. Its aim is to help States improve their laws, policies and institutions associated with fishing and aquaculture, and to promote the use of fish, the protection of the environment and coastal areas, as well as ecosystem research. The FAO agreed to monitor and update the Code, while States are encouraged to promote and explain the Code to stakeholders. The Code also stresses capacity building to aid developing nations.

The Code's general principles involve the conservation of aquatic ecosystems (see Text Box 10). An important principle is established by the Code; that "the right to fish carries with it the obligation to do so in a responsible manner so as to ensure effective conservation and management of the living aquatic resources". This in itself calls for fishers and fishery managers to adopt an "ecosystem approach" as a necessary duty if the resource of a fish stock is to be used by man while ensuring the conservation of "living aquatic resources", i.e. the marine ecosystem.

Scientifically, the Code emphasises the need of a multi-disciplinary approach, as management must take into account all relevant environmental factors. Research, monitoring and assessment is called for in the areas of biology, ecology and environmental sciences, as well as in socio-economic aspects. From a managerial stand point, the Code calls for management to be based on the precautionary approach, but also to document and use traditional knowledge of fishers. It also suggests that fisheries management should be incorporated into Integrated Coastal Zone Management (ICZM).

Other sections of the Code cover aspects such as international trade, settlement of disputes, education and training, health and safety, working conditions, enforcement and surveillance, the duties of flag States and coastal states, energy conservation, protection of the environment and atmosphere, abandonment of structures at sea, artificial reefs, aquaculture and post-harvest practice and trade.

7.2 Reykjavik Conference on Responsible Fisheries in the Marine Ecosystem (2001)

An FAO conference was held in Reykjavik, Iceland, in 2001 in order to assess implementation and progress of the FAO Code of Conduct since its publication in 1995. While the Code itself never refers to the term "ecosystem approach", this concept was a fundamental aspect of many of the papers presented during the scientific part of the Conference. Clearly the underlying concepts expressed in the original Code had become embodied in the overall concept of an "ecosystem approach" during the intervening six year period, no doubt influenced by the developments within the UNCED process.

The objectives of the Conference were to gather and review the best available knowledge on marine ecosystem issues, to identify means by which ecosystem considerations can be included in capture fisheries management, and to identify future challenges and relevant strategies. Science sessions covered dynamics of marine ecosystems, the role of man in marine ecosystems and incorporating ecosystem considerations in fisheries management.

7.3 Reykjavik Declaration (2001)

FAO members declared in Reykjavik that, in an effort to reinforce responsible and sustainable fisheries in the marine ecosystem, they will individually and collectively work on incorporating ecosystem considerations into fisheries management. The Conference Declaration fundamentally places ecosystem concerns at the heart of fisheries management (Text Box 11), as well as making the important point that States must "improve cooperation between [regional and international fisheries management organisations] and regional bodies in charge of managing and conserving the marine environment". This must apply equally to local and national bodies involved in fishery and environmental management and conservation.

The Declaration finishes by emphasising the determination to strengthen international cooperation, through education and training, in the collection and processing of biological, oceanographic, ecological and fisheries data. This data is needed for the design, implementation and upgrading of management strategies.

The Declaration was taken forward to the UN, the FAO and the WSSD 2002 by the Government of Iceland.

7.4 Present Status (2004)

The FAO continues its lead role in international fisheries policy. It has established International Action Plans, presently aimed at managing fishing capacity, reducing illegal and unreported catches, reducing incidental deaths of seabirds, and conserving shark populations.

Text Box 11: The FAO Reykjavik Declaration (2001)

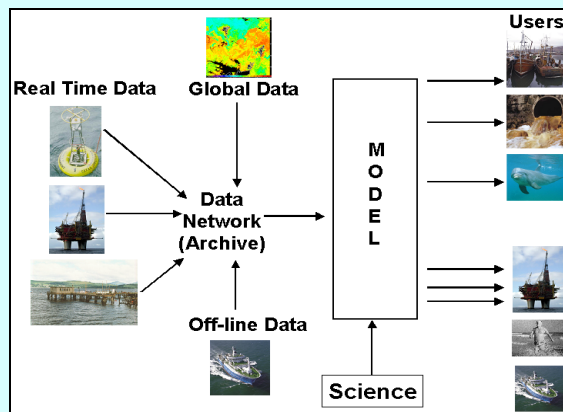
The 2001 Reykjavik Conference on Responsible Fisheries confirmed, in an adopted declaration, that

- sustainable fisheries management must;
 - incorporate ecosystem considerations
 - take into account the impacts of fisheries on the marine ecosystem
 - take into account the impacts of the marine ecosystem on fisheries
 - contribute to the effective conservation of the ecosystem and its resources
- however, fishery managers are forced to take immediate action to address particularly urgent problems on the basis of the precautionary approach
- the inclusion of ecosystem considerations in fisheries management provides a framework which enhances management performance
- there is a clear need to introduce effective management plans with;
 - incentives that encourage responsible fisheries
 - incentives to encourage sustainable use of marine ecosystems
 - mechanisms for reducing excessive fishing efforts to sustainable levels
- regional and international fisheries management organisations must;
 - be strengthened
 - incorporate in their work ecosystem considerations
 - improve cooperation with those in charge of managing and conserving the marine environment
- ecosystem science has to be advanced to identify and describe;
 - the structure, components and functioning of marine ecosystems
 - diet composition and food webs
 - species interactions and predator-prey relationships
 - the role of habitat
 - the relevant biological, physical and oceanographic factors
- systematic monitoring is needed of;
 - natural variability
 - its relationship to ecosystem productivity
 - catch, by-catch and discards
- research is needed to develop fishing gear and practices;
 - to improve gear selectivity
 - to reduce adverse impacts on habitat and biological diversity

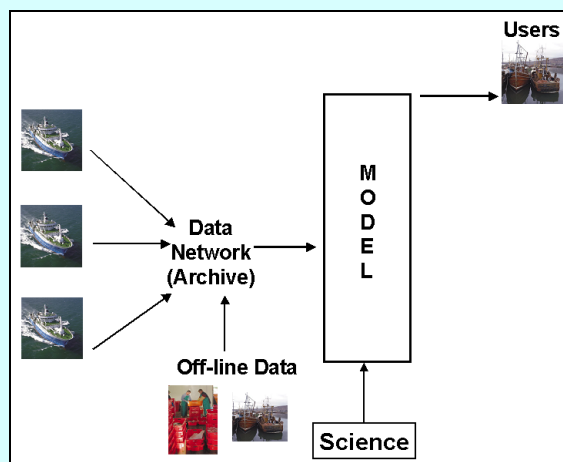
Fisheries Management— A Real Example of an OOS

Present day, single-species fisheries management is an excellent example of a functioning Operational Observing System (OOS).

The figure below shows one vision of the basic aspects of an OOS. Real-time regional data collected from a variety of platforms is merged with global data sets, such as from satellites, as well as “off-line” data such as climatologies built up from monitoring or research projects. A data network feeds the data in an appropriate form to a model which assimilates the data, using the principal forcing mechanisms identified by science, in order to deliver relevant products in a timely way to end-users. Often a range of customers can benefit from the same operational system. In this case principal customers are identified as managers of fisheries, pollution and nature conservation, with secondary customers as the oil and gas and leisure industries, as well as the scientific community itself. Finally, science continuously improves the “expertise” of the modelling system through research.



Present day fisheries management relies on the annual collection of fish stock statistics, from surveys performed by fishery institutes as well as from “off-line” sources such as the industry itself and market sampling. The data is compiled in a regular and agreed way, and used to drive Virtual Population Analysis (VPA) models, incorporating the science of population dynamics, in order to arrive at assessments of stock size. These assessments are turned into advice which is delivered to the European Commission so that managers can make decisions about the fisheries. Much research is underway into methods to improve the accuracy of the population models.



For the North Sea, if the cost of research vessel surveys, industry monitoring, data quality control, collation, synthesis and interpretation, and product preparation and delivery is summed, it would be approximately €40 million in 2003. If the same addition is performed for work in the North Sea to support the assessment of ocean climate, it would be less than €1 million. One challenge of the “ecosystem approach” is to rectify this imbalance in funding, and ICES and EuroGOOS are in a position to champion such change.

8 Discussion

The review of global ocean governance policy drivers presented here demonstrates the evolution that has led to the present cloud of ideas, concepts and tools which represent the present form of an “ecosystem approach” to fisheries management. National, regional and international Governments, governmental institutes and organisations, as well as stakeholders and stakeholder organisations, are presently trying to disentangle, or “unpack” these concepts in order to arrive at a realistic, pragmatic and workable way forward towards a new approach to operational management which will replace or augment the present single-species, fish-stock orientated methods.

Over the 30 year period since the Stockholm Declaration a series of management concepts, management tools and scientific tools (Table 1) have all been linked with the “ecosystem approach”. Numerous definitions, criteria and frameworks have been put forward by various working groups and organisations trying to define an “ecosystem approach” (e.g. Annex 2). These vary in their helpfulness, when compared with the original concepts outlined in the Stockholm Declaration. Of the scientific tools, each one individually can be identified with a set of conferences, national and international working groups all attempting to further “unpack” the concept of each tool, and how it may be applied in reality. Thus much effort has resulted in little progress towards a working version of the “ecosystem approach”.

The statutory nature of many of the governance policy instruments outlined here has resulted in their implementation within national and regional laws. For example, in Canada the Oceans Act provides the statutory framework for ecosystem management, while in Europe the European Commission have implemented, and are developing, a raft of marine-related Directives, each addressing a different aspect of the global drivers described here. Thus the “ecosystem approach” developed in any region must also satisfy these local legal instruments.

As an aside, it is notable that every single global driver refers to the concepts of free data exchange, capacity building and education. Very little attention has been paid to these three issues by the marine science community to date.

The first time the term “ecosystem approach” actually appears in a global driver document is within the CBD Conference of Party Decisions. The “ecosystem approach” was initiated by the COP Decisions in a confused series of statements which relate it, on the one hand to the development of ecosystem models through multi-disciplinary scientific research in order to augment a mono-species modelling approach, and on the other to the development of holistic management practices for the sustainable use of marine resources. Perhaps this confused birth is partly responsible for the vast range of interpretation of what an “ecosystem approach” actually is, and the vast range of definitions, documents and meetings the phrase has spawned.

The UNCED process has vital importance to issues such as world poverty and sustainable development. However, from a limited perspective focusing on issues relating to fisheries management, the impression one receives when reading the Declarations of the UNCED process (Stockholm 1972, Rio 1992, Johannesburg 2002), is that the underlying clarity of thought focusing on pragmatic action has reduced over the last three decades, while the reliance on grand, political vision statements has increased. There must be a real fear that, by trying to do everything, we will achieve nothing. Marine scientists and the scientific-policy community are presently enveloping the “ecosystem approach” with too many layers of complexity, detail and tools which in themselves become the focus of the approach, forgetting what should be the underlying principles of any “ecosystem approach”: i.e.

- all aspects of the ocean are interrelated and should be treated as an integral whole (Arvid Pardo)
- In order to achieve a more rational management of resources and thus to improve the environment, States should adopt an integrated and co-ordinated approach to their development planning so as to ensure that development is compatible with the need to protect and improve environment for the benefit of their population (Article 13, Stockholm Declaration).

The first of these two concepts is a message to marine scientists to more fully engage between disciplines in order to understand, assess, monitor

and model the marine ecosystem. It can be seen that national institutes most often separate scientific disciplines within separate Departments, rather than unifying them in regional ecosystem-focused Departments. Similarly, international science organisations such as ICES often separate disciplines within individual science committees.

The second is a message to Governments, who must reorganise the structures with which they manage marine resources, including fisheries. Most ICES countries still have separate fishery and environment departments, each with their separate institutes, instruments and organisations. Few have ecosystem-centred Departments where decisions regarding both fisheries and the environment can be achieved in a regional holistic, unified sense.

Over the last three decades focus has been diverted to the tools of an “ecosystem approach” (monitoring, indicators, ecological quality objectives, status reports, protected areas, pilot projects) and away from the underlying concept; that of unifying science disciplines and unifying the decision-making process. These two changes are fundamentally repulsive to many of the scientists and managers involved. It means breaking down traditional and entrenched boundaries, as well as loss of perceived “ownership” of departments and divisions. Unless we return to the basic philosophies that lie at the foundation of the three strands of global ocean governance, and implement them, the “ecosystem approach” is most likely doomed to failure from the outset.

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Annex 1: Definition of Relevant Terms from the CBD

Biological diversity means the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems.

Note: In this paper the term **Biological Diversity** and **Biodiversity** are equivalent.

Biological resources includes genetic resources, organisms or parts thereof, populations, or any other biotic component of ecosystems with actual or potential use or value for humanity.

Biotechnology means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use.

Ecosystem means a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit.

Genetic material means any material of plant, animal, microbial or other origin containing functional units of heredity.

Genetic resources means genetic material of actual or potential value.

Habitat means the place or type of site where an organism or population naturally occurs.

In situ conditions means conditions where genetic resources exist within ecosystems and natural habitats, and, in the case of domesticated or cultivated species, in the surroundings where they have developed their distinctive properties.

Protected area means a geographically defined area which is designated or regulated and managed to achieve specific conservation objectives.

Sustainable use means the use of components of biological diversity in a way and at a rate that does not lead to the long-term decline of biological diversity, thereby maintaining its potential to meet the needs and aspirations of present and future generations.

Annex 2: The CBD Guidance for an “Ecosystem Approach”

From COP Decision V/6, and the Malawi Workshop Report:

1. An “ecosystem approach” is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way.
2. An “ecosystem approach” is based on the application of appropriate scientific methodologies focused on levels of biological organisation which encompass the essential processes and interactions amongst organisms and their environment. The ecosystem approach recognises that humans are an integral component of ecosystems.
3. An “ecosystem approach” focuses on structure, processes, functions and interactions within an ecosystem, which is a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit and can be any functioning unit at any scale.
4. An “ecosystem approach” requires adaptive management to deal with the complex and dynamic nature of ecosystems and the absence of complete knowledge or understanding of their functioning.
5. An “ecosystem approach” does not preclude other management and conservation approaches, such as biosphere reserves, protected areas, and single-species conservation programmes already carried out under existing national policy and legislative frameworks, but could, rather, integrate all these approaches and other methodologies to deal with complex situations.
6. There is no single way to implement the “ecosystem approach”, as it depends on local, provincial, national, regional or global conditions. Indeed, there are many ways in which ecosystem approaches may be used as the framework for delivering the objectives of the Convention in practice.
7. Twelve principles for an “ecosystem approach”
 - a. Management objectives are a matter of societal choice. Ecosystems should be managed for their intrinsic values and for the tangible or intangible benefits for humans, in a fair and equitable way.
 - b. Management should be decentralised to the lowest appropriate level, involving all Stakeholders.
 - c. Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
 - d. As there are potential gains from management, there is a need to understand the ecosystem in an economic context. Any such ecosystem-management programme should (a) Reduce those market distortions that adversely affect biological diversity; (b) Align incentives to promote biodiversity conservation and sustainable use; (c) Internalise costs and benefits in the given ecosystem to the extent feasible.
 - e. A key feature of an “ecosystem approach” includes conservation of ecosystem structure and functioning. The conservation and restoration of ecosystem interactions and processes is of greater significance for the long-term maintenance of biological diversity than simply protection of species.
 - f. Ecosystems must be managed within the limits to their functioning. In considering the likelihood or ease of attaining the management objectives, attention should be given to the environmental conditions that limit natural productivity, ecosystem structure, functioning and diversity.
 - g. An “ecosystem approach” should be undertaken at the appropriate scale, with management boundaries defined operationally by users, managers, scientists and local peoples.
 - h. As varying temporal scales and lag effects exist which characterise ecosystem processes, objectives for ecosystem management should be set for the long term.
 - i. Management must recognise that change is inevitable. Traditional disturbance regimes may be important for ecosystem structure and functioning, and may need to be maintained or restored. Adaptive

management must cope with long-term effects such as climate change.

- j. An “ecosystem approach” should seek the appropriate balance between conservation and use of biological diversity. Conservation and use should be seen in context and the full range of measures applied in a continuum from strictly protected to human-made ecosystems.
 - k. An “ecosystem approach” should consider all forms of relevant information, including scientific and local knowledge, innovations and practices. Assumptions behind proposed management decisions should be made explicit and checked against available knowledge and views of stakeholders.
 - l. An “ecosystem approach” should involve all relevant sectors of society and scientific disciplines.
8. Five operational guidelines for an ecosystem approach are:
- a. **Focus on Ecosystem Function:** A knowledge of ecosystem functions and structure, and the roles of the components of biological diversity in ecosystems, is required, especially to understand:
 - i. ecosystem resilience and the effects of biodiversity loss (species and genetic levels) and habitat fragmentation
 - ii. underlying causes of biodiversity loss
 - iii. determinants of local biological diversity in management decisions.However, ecosystem management has to be carried out even in the absence of such knowledge.
 - b. **Enhance benefit-sharing:** Benefits that flow from the array of functions provided by biological diversity at the ecosystem level provide the basis of human environmental security and sustainability. The ecosystem approach seeks that the benefits derived from these functions are maintained or restored. In particular, these functions should benefit the stakeholders responsible for their production and management.
 - c. **Use Adaptive Management:** Ecosystem processes and functions are complex and variable. Their level of uncertainty is increased by the interaction with social constructs, which need to be better understood. Therefore, ecosystem management must involve a learning process, which helps to adapt methodologies and practices to the

ways in which these systems are being managed and monitored. Implementation programmes should be designed to adjust to the unexpected, rather than to act on the basis of a belief in certainties. Long-term, inflexible decisions are likely to be inadequate or even destructive. Ecosystem management should be envisaged as a long-term experiment that builds on its results as it progresses, i.e. “learning-by-doing”.

- d. **Manage at an appropriate scale:** Often, this approach will imply decentralization to the level of local communities. Effective decentralization requires proper empowerment, which implies that the stakeholder both has the opportunity to assume responsibility and the capacity to carry out the appropriate action, and needs to be supported by enabling policy and legislative frameworks. Where common property resources are involved, the most appropriate scale for management decisions and actions would necessarily be large enough to encompass the effects of practices by all the relevant stakeholders. Appropriate institutions would be required for such decision-making and, where necessary, for conflict resolution. Some problems and issues may require action at still higher levels, through, for example, transboundary cooperation, or even cooperation at global levels.
- e. **Ensure inter-sectoral cooperation:** The ecosystem approach should be fully taken into account in developing and reviewing national biodiversity strategies and action plans. Management of natural resources, according to the ecosystem approach, calls for increased inter-sectoral communication and cooperation at a range of levels (government ministries, management agencies, etc). This might be promoted through, for example, the formation of inter-ministerial bodies within the Government or the creation of networks for sharing information and experience.