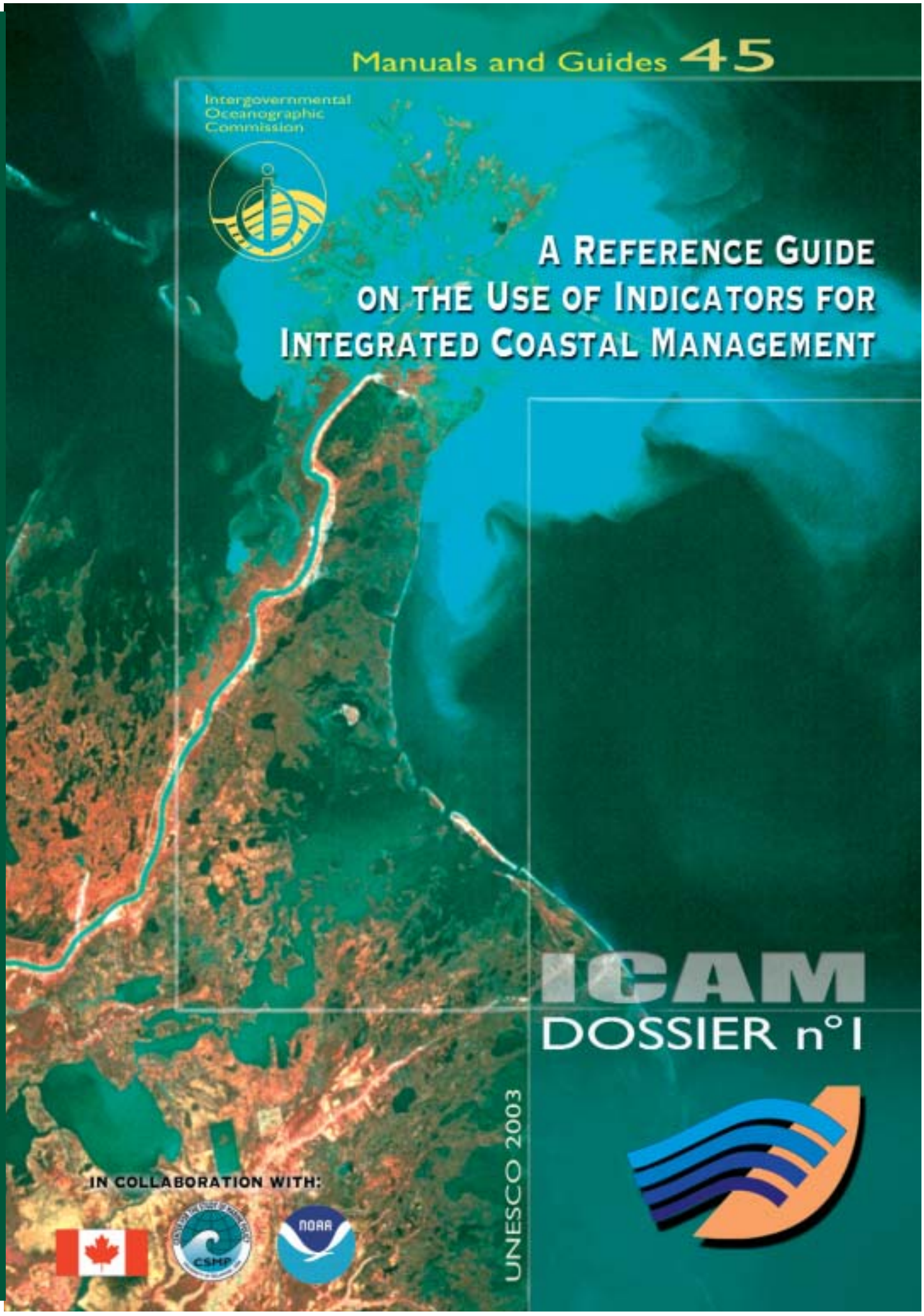

Manuals and Guides 45
Intergovernmental Oceanographic Commission
A REFERENCE GUIDE ON THE USE OF INDICATORS FOR INTEGRATED COASTAL MANAGEMENT
ICAM
DOSSIER n°1
IN COLLABORATION WITH:
CSMP
NOAA
UNESCO 2003

ICAM
DOSSIER

Intergovernmental Oceanographic Commission of UNESCO

A Reference Guide on the Use of Indicators for Integrated Coastal Management

Prepared by
Stefano Belfiore, Miriam Balgos,
Bernice McLean, Jordi Galofre,
Meredith Blaydes, and Danielle Tesch

In collaboration with:

Department of Fisheries and Oceans
Government of Canada

Center for the Study
of Marine Policy

National Oceanic and
Atmospheric Administration

Edited by Julian Barbière
Layout and design by Eric Loddé

For bibliographic purposes, this document should be cited as follows: A Reference Guide on the Use of Indicators for Integrated Coastal Management - ICAM Dossier 1, *IOC Manuals and Guides No. 45.* UNESCO 2003 (English).

The preliminary version of this document was prepared as part of a contract from the Department of Fisheries and Oceans (DFO) to the Center for the Study of Marine Policy, Dr. Biliana Cicin-Sain, Principal Investigator, for the international workshop 'The Role of Indicators for Integrated Coastal Management', organized by DFO and IOC in Ottawa on April 29, May 2002

Printed in 2003
by the United Nations Educational, Scientific and Cultural Organization
7, place de Fontenoy, 75352 Paris 07 SP, France

(SC–2003/WS/3)

Table of contents

Foreword

Integrated Coastal Area Management (ICAM) is a process that unites government and the community, science and management, sectoral and public interests in preparing and implementing an integrated plan for the protection and development of coastal ecosystems and resources. The ICAM approach has been recognized by UNCED, and more recently by WSSD, as well as several global and regional conventions (CBD, 1995, GPA-LBA, 1995; Regional Seas Conventions) as the appropriate tool to ensure the sustainable development of coastal areas. In 2000, more than 98 coastal nations were engaged in ICAM initiatives or programmes. The development of efficient management plan of complex ecosystems subject to significant human pressure cannot occur in the absence of science. The natural sciences are vital to understanding the functioning of the ecosystem and the social sciences are essential to comprehending why humans behave in ways that cause ecological problems and can contribute to their solution.

In response of the growing needs of coastal nations, IOC has established since 1998 a dedicated programme on ICAM to assist IOC Member States in their efforts to build marine scientific and technological capabilities in the field of coastal management, and to ensure that scientific requirements are integrated into the development of national and regional ICAM programmes and plans. In particular, ICAM is promoting, through the exchange of experiences, the development of scientifically based methodologies, tools and services to assist the decision-making process and their corresponding institutions for the sustainable development of coastal areas.

This new ICAM Dossier Series is meant to serve as a vehicle for describing, discussing and enhancing our understanding of the complex machinery behind the recognised principles of integrated coastal management. Each Dossiers will address a specific issues, bringing up the current knowledge of the 'Coastal management Community' on the application of specific ICAM tools and methodologies at the science-policy interface, where both social and natural sciences are required. The Dossier will also present case studies and demonstration projects that highlight specific practical experiences. These Dossiers are targeted to suit the need of scientists, ICAM practitioners as well as advanced students in the field of coastal sciences and planning.

This first issue is devoted to the use of indicators for ICAM, and is a direct result of the IOC-DFO-NOAA-CSMP International Workshop on the same topic, organised in May 2002, in Ottawa. Based on a background paper prepared by the Center for the Study of Marine Policy (University of Delaware) in preparation for the workshop, the aim of this Reference Guide is to present a literature review on the use of indicators around the world, from various programmes and projects, at global, regional, national and local scale. The need for indicators and reporting techniques which reflects the performance of coastal management projects and programmes and reveals the complex relationship that exist between coastal ecosystem health and anthropogenic activities, socio-economic conditions and managerial decisions, has been reinforced recently by the World Summit on Sustainable Development's Plan of Implementation. This Dossier will hopefully offer a first step towards the development of common practices and protocols in the application of such indicators.

Patricio A. Bernal
Executive Secretary
Intergovernmental Oceanographic Commission

This ICAM Dossiers exists in electronic format and can be downloaded from the IOC/ICAM web site at http://ioc.unesco.org/icam/

Executive Summary

This reference guide is an updated version of the background paper to the international workshop *The Role of Indicators in Integrated Coastal Management* (Ottawa, April 29–May 1, 2002). The guide is based on a literature review on the use of coastal indicators at the global, regional, national, and local level and is intended to provide a contribution to the selection of a short list of measurable variables addressing the major issues in integrated coastal management (ICM), in environmental, socioeconomic, and governance performance terms.

There is general international recognition of ICM to address in a holistic way the environmental and developmental challenges of coastal zones. Agenda 21, Chapter 17, the Convention on Biological Diversity (CBD), the Barbados Action Plan, the Global Programme of Action for the Protection of the Marine Environment from Land-Based Sources (GPA), the FAO Code of Conduct for Responsible Fishing all call for a cross-sectoral approach to the management of coastal areas.

Guidelines for ICM developed by international organizations, UNEP, FAO, and the EU, in particular, have underlined the relevance of indicators to monitor changes in the state of the coastal and marine environments, assess trends in socioeconomic pressures and conditions in the coastal areas, and appraise the effectiveness of ICM efforts in addressing these issues.

The scientific and technical literature and the practical experience have highlighted the need to develop indicators to assess the performance of the numerous and long-standing ICM efforts developed at all levels. This is particularly true considering the high levels of investments in ICM initiatives by both national and international sources.

Environmental indicators applicable to the coastal zone have been developed within the context of large-scale research programs at the global level and are used in the framework of state of the environment reports at the national level, eventually within regional initiatives. Typically, environmental indicators are developed within the OECD Pressure-State-Response (PSR) framework or extended models and are useful to monitor the state of the coastal and marine environment.

Environmental indicators tend to be physical or biological in nature, rather than being oriented towards management processes. Many countries are now devoting more attention to the development of indicators that would allow an assessment of whether current or planned uses of the coastal zone are actually sustainable.

While the use of coastal indicators is still limited, it appears that recently in various countries there has been some progress in the application of environment indicators to: (a) reducing "point" sources of pollution; (b) applying classical land-use planning techniques to coastal zone and protected areas, and (c) providing public access to beaches.

On the other hand, examples of socioeconomic indicators, intended to describe socioeconomic conditions in the coastal zone, are rare, especially at the national level. In state of the environment reports, socioeconomic indicators are developed for broader application and subnational programs are expected to develop specific socioeconomic indicators under various themes including coasts and oceans, based on issue focuses that vary from country to country. Socioeconomic indicators can provide a useful means to represent the human component of coastal systems as well as a tool in the development of ICM strategies and projects.

It is also a possibility that examples of well-developed socioeconomic indicators for the coastal zone are rare either because monitoring and evaluation systems are not developed at the onset of project planning or are developed but not intended to cover the measurement of impacts.

Issue-specific global programs such as the Millennium Ecosystem Assessment and the World Commission on Protected Areas (WCPA) Marine program which follow an integrated approach or perspective with a focus on ecosystems and marine protected areas (MPAs), respectively, have developed socioeconomic indicators. These programs look at both environmental and socioeconomic aspects and their interaction. MPA programs, in general, value environmental as well as socioeconomic benefits. Additional insights on the socioeconomic value of coral reefs are provided by the experience of the Global Coral Reef Monitoring Network (GCRMN).

Subnational, e.g., state, local, or site-specific coastal management programs, have socioeconomic indicators that describe specific socioeconomic impacts of program components. Within focus areas that are targeted by program components, outputs (process indicators) and impacts, including socioeconomic indicators are described.

The use of governance performance indicators for ICM is still in its infancy. Some efforts have been carried out to monitor progress of ICM at the global (OECD), regional (EU), and program level (most notably by the Coastal Resources Center [CRC]). Difficulties are apparent, in particular, in tying ICM efforts to on-the-ground changes. The attribution of effects to ICM programs remains an open issue.

At the program and project level, the input-output-outcome-impact framework developed by the World Bank, as well as the outcome evaluation model, provide an important framework. This approach has to be accompanied by the setting of specific goals and baselines for ICM programs to monitor their effects. On these lines, attempts are being made, for example in the U.S. and Australia, to focus future efforts on the assessment of the performance of state ICM programs, for their broader evaluation in a national context.

This calls for more systematic evaluations of ICM efforts, shifting from the use of sole environmental indicators to the use of the PSR model in the context of the ICM cycle. This model is particularly needed to demonstrate the socioeconomic benefits of ICM. Integrating environmental, socioeconomic, and governance aspects and developing indicators capable of capturing these processes remains one of the most difficult challenges for the ICM approach.

Among the recommendations that could be drawn from the literature on coastal indicators, the following are noteworthy:

- It is important for ICM programs to adopt objective-based outcome evaluations, defining environmental and socioeconomic goals and establishing baselines against which to measure the impact of ICM initiatives. To this end, the causal relationships linking environmental, socioeconomic, and governance components must be identified.
- Indicators should be user-led and coastal stakeholders should be involved in the process of selection and development of indicators from the beginning. In most cases, given the potential high cost associated with the development of complex indicators, the best use should be made of existing information derived from different types of programs. On this basis, an enhanced report on the state of the environment and development of the coastal zone could provide an occasion for collaboration between subnational and national levels for the achievement of shared objectives.
- Existing information could be enhanced by: (a) compiling baseline information on the condition of ecosystems, (b) standardizing, compiling and harmonizing existing data sets to develop global data sets, (c) identifying areas of high conservation priority, patterns of ecosystem interlinkage, and causal relationships in systems, (d) utilizing multiple methods for monitoring and assessment, (e) improving integration and collaboration among coastal zone agencies and initiatives; and (f) developing techniques for governments and nongovernmental organizations to engage policymakers and civil society for better evaluation of tradeoffs and improved decision making.
- Monitoring and evaluation mechanisms have to be incorporated from the beginning, while program monitoring must be linked to evaluation throughout project implementation. Indicators must therefore be set as an integral part of a program or project proposal, and revised in response to adjustments to project objectives, interventions, and implementation mechanisms are made. This would allow for improved

accounting of project progress and achievements in the reporting process to donor agencies.

- The development of mechanisms such as the coastal module of GOOS should be supported to enable regular ecosystem assessments and improve sustainable development and management of global coastal ecosystems.
- An indicator system for ICM could be developed linking environmental and socioeconomic indicators with indicators to monitor progress in ICM. The indicator system itself could be developed through a phased approach tied to the ICM cycle. This could also provide for the identification of best practices in the use of coastal indicators and their broader applicability.
- The use of headline indicators for ICM appears particularly important: headline indicators could be based on combined indicators expressing more complex phenomena or effect-related equivalents. Headline indicators for ICM should be selected based on the following characteristics: policy relevance; predictability; interdependency; measurability; and performance.
- Indicators must be anchored on a generic framework for ICM in order to:
  - Promote a more community-based approach to coastal management, increasing public participation in ICM planning and decision-making.
  - Place more emphasis on ICM programs and activities in the development of indicators.
  - Give proper attention to the development and monitoring of ICM indicators.
  - Focus on the resolution of international ICM problems, using a regional approach.
  - Re-examinine the effectiveness of ICM policies through time.
- In the development and application of coastal indicators, a series of principles should be taken into account:
  - Indicators provide one of the tools in the process of performance evaluation and need to be supplemented by other qualitative and scientific information.
  - There is no unique normalization for the comparison of environmental variables across countries.
  - The core sets of indicators developed by OECD and the EEA provide a fundamental basis for the development of environmental indicators. However, when the motivation for coastal management evolves from pressures towards sustainability and improvement of management strategies, other more appropriate models and corresponding sets of indicators need to be developed.
  - In both conceptual and empirical terms, indicators of societal responses tend to be less advanced than indicators of environmental pressures or indicators of environmental conditions. Thus, particular caution must be used in setting and using socioeconomic indicators.
  - For performance evaluation, indicators must be reported and interpreted in the appropriate context, taking into account the ecological, geographical, social, economic and structural features of countries.
  - Not every area of assessment lends itself to the use of quantitative information. Certain policy areas should be assessed in qualitative terms.
  - Environmental issues do not necessarily have a one-to-one correspondence with identified indicators.

Acronyms

BP/RAC	Blue Plan Regional Activity Centre
CAMP	Coastal Area Management Programme
CBD	Convention on Biological Diversity
CEE	Central and Eastern Europe
COOP	Coastal Ocean Observations Panel
CRC	Coastal Resources Center
CSD	Commission on Sustainable Development
CSMP	Center for the Study of Marine Policy
CZMA	Coastal Zone Management Act
DFO	Department of Fisheries and Oceans
DSS	Decision Support Systems
EEA	European Environment Agency
EFTA	European Free Trade Area
EPA	Environmental Protection Agency
EPI	Environmental Performance Indicator
EU	European Union
FAO	Food and Agriculture Organization
GCRMN	Global Coral Reef Monitoring Network
GIS	Geographic Information Systems
GIWA	Global International Waters Assessment
GOOS	Global Ocean Observing System
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities
HOTO	Health of the Ocean
ICAM	Integrated Coastal Area Management
ICRAM	Integrated Coastal and River Area Management
ICM	Integrated Coastal Management
IGU	International Geographical Union
IM	Integrated Management
IMCRA	Interim Marine and Coastal Regionalization for Australia
IOC	Intergovernmental Oceanographic Commission
MEQ	Marine Environmental Quality
MPA	Marine Protected Areas
MEA	Millennium Ecosystem Assessment
NERR	National Estuarine Research Reserve
NIS	Newly Independent States
NOAA	U.S. National Oceanic and Atmospheric Administration
OECD	Organisation for Economic Co-operation and Development
PAGE	Pilot Analysis of Global Ecosystems
PSR	Pressure-State-Response
SDRS	Sustainable Development Reference System
STAR	Sustainability Targets and Reference Values
UN	United Nations
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
WCPA	World Commission on Protected Areas
WRI	World Resources Institute

1. Introduction

1.1 Context and aims of the guide

During the 33rd Executive Council of the Intergovernmental Oceanographic Commission (IOC) of UNESCO, held in Paris in 2000, the delegation of Canada emphasized the need to improve the design, and diffuse the use of indicators in coastal area management, particularly of those that are concerned with the interaction between ecological processes and local socioeconomic systems. In this regard, it was suggested that a scientific discussion on this issue be convened by the Department of Fisheries and Oceans (DFO), Canada, and IOC with the aim of implementing interdisciplinary approaches in the field.

On April 29-May 1, 2002, the international workshop on *The Role of Indicators in Integrated Coastal Management* was organized in Ottawa by DFO and IOC, with the sponsorship of the U.S. National Oceanic and Atmospheric Administration (NOAA) and the International Geographical Union (IGU). The Center for the Study of Marine Policy (CSMP) of the University of Delaware acted as workshop organizer and secretariat.

The aims of the workshop were to:

1. Assess the state of the development and use of different types of indicators — environmental, socioeconomic, and governance performance — to monitor the effectiveness of integrated coastal management (ICM) efforts;
2. Review selected national and local case studies in the application of coastal management indicators; and
3. Develop a common framework and template for the selection and application of coastal management indicators in different contexts.

The workshop was attended by 40 participants from 11 countries (Australia, Canada, France, Italy, Jamaica, Netherlands, Philippines, South Africa, Spain, Tanzania, and USA).

The Secretariat provided the participants with a background document based on a literature review on the development and use of indicators for ICM. The background document provided the basis for discussion at the workshop working groups.

The workshop featured 12 presentations divided into four sections: (1) introductions to different types of indicators, (2) case studies from international programs, (3) case studies on the application of indicators, and (4) frameworks for the use of indicators for ICM (for the detailed program of the events, see the workshop report, Appendix I).

Participants attended working groups which addressed each major class of indicators (environmental, socioeconomic, governance), including crosscutting issues such as quantitative objectives, goals, and scale of application of indicators; outcome mapping and measurement of performance; and integration of different types of indicators to address specific policy issues. The results of the working groups were then discussed in plenary for the adoption of practical recommendations targeted to the user community.

The outcomes of the workshop consisted of:

1. A discussion on the possible frameworks that could be used to integrate different types of indicators in ICM programs and plans;

2. A tentative list of indicators for measuring environmental state, socioeconomic pressures; conditions, and governance performance; and
3. A discussion on the shortcomings of indicators.

As a follow-up to the event, the following actions were envisaged:

- The operation of an electronic discussion group (icm-indicators@udel.edu) to advance the discussion on indicators on ICM among participants;
- The enhancement of the workshop Web site (http//www.udel.edu/CMS/csmp/indicators/), through presentation of the workshop materials (papers and presentations) and the development of links to programs and initiatives on indicators;
- The refinement of the background document based on further literature sources;
- The preparation of a special issue of the *Ocean & Coastal Management* journal on the use of indicators for ICM; and
- The preparation of a methodological reference guide on the use of indicators for ICM, to be published by IOC (This volume/Manual 4).

This reference guide, based on the background document distributed at the workshop, represents an intermediate document for the preparation of the final methodological guide, which will be developed by an international team of experts convened under the aegis of IOC.

The aim of this reference guide is therefore to provide general information on the main concepts, approaches, and experiences in the use of indicators to monitor the progress towards sustainable development in the coastal zone and to assess the effectiveness of coastal management efforts. In addition, the guide provides suggestions on the use of a limited number of key indicators for ICM.

1.2 Methodology and structure

The reference guide is based on the literature review provided by the background paper, the suggestions provided by the members of the Steering Committee, the workshop presentations, and the discussion among the workshop participants. The aim of the guide is to produce a series of recommendations on the selection of a limited number of indicators of broader applicability that could be used at different levels —national, subnational, local — to assess the effectiveness of coastal management efforts.

The recommendations pay particular attention to: current methodologies used to monitor the state of the coastal zones, the pressures impending on those methodologies, and the policy measures adopted to manage them. On this basis, the recommendations promote the use of a selection of indicators, which are needed and could prove useful in the future, provided that they correspond to a series of characteristics.

The review of the literature and practices of coastal indicators carried out in the reference guide and interviews with coastal management and academic experts cover different aspects:

- International efforts to develop sustainable development indicators for ocean and coasts;
- Regional efforts to develop indicators for sustainable coastal development;
- National case studies on the use of coastal indicators; and
- International and national experience in evaluating and monitoring coastal management programs and projects.

In reviewing the literature, attention has been paid to the main goals pursued by coastal management efforts, in order to consider the appropriateness of indicators only in relation to the measurement of stated goals.

The guide herein is organized in several parts.

Chapter 2, "Integrated Coastal Management and indicators: concepts and approaches", discusses the policy cycle of ICM with consideration of the role of indicators as suggested by international guidelines. The main types of indicators relevant to ICM are reviewed in terms of their definitions, models and approaches, and geographic and time scales of application. A discussion of the main characteristics of ICM indicators suitable to this context is provided.

Chapter 3, "The state of coastal and marine environment: environmental indicators," reviews methods and practices for measuring the state of coastal and marine environments, making use of case studies to illustrate environmental indicators relevant on a global, regional, and national scale. Based on the review, a selected list of

indicators to measure the state of the environment in coastal and marine areas is provided.

Chapter 4, "Socioeconomic Pressures and Benefits: Socioeconomic Indicators," addresses methods and practices of indicator utilization to report and measure human activities and conditions on the coastal zone and how these are linked to ICM efforts. Case studies at the level of global observation programs (e.g., the coastal component of the Global Ocean Observing System – GOOS) and regional socioeconomic assessments (e.g., in the EU) will shed some light on current developments. This part is concluded with suggestions of a limited number of socioeconomic indicators.

In Chapter 5, "Policy response: governance indicators," examines indicators to measure governance performance. Emphasis is placed on methods and practices in indicators to measure the processes involved in the ICM policy cycle, namely, inputs and outputs. The common system of indicators to measure progress of ICM in the U.S. coastal states serve as a case study together with other examples. This helps to highlight a suite of process indicators useful for measuring progress in ICM.

Chapter 6, "Mapping outcomes and effectiveness of integrated coastal management," focuses on the effectiveness of ICM efforts and indicators to measure outcomes and impacts. The methods and practices reviewed are followed by different case studies: for example, a global initiative to measure effectiveness of marine protected areas and the application of an outcome-based assessment of ICM efforts in France by the national Coastal Environment Commission. This provides a basis for suggestions of a number of indicators for outcome mapping.

Finally, a series of findings and recommendations are detailed with the aim of eliciting discussion on a possible set of selected indicators of broad applicability to measure performance of ICM efforts. The guide is concluded by references and a glossary.

2. Integrated coastal management and indicators: concepts and approaches

2.1 The integrated coastal management process and its evaluation

Sustainable development goals and objectives for coastal areas

An integrated cross-sectoral approach to the management of coastal areas — integrated coastal management (ICM) — has been called for by all the major international agreements on oceans and coasts (Box 2.1).

Box 2-1 The call for integrated coastal management in the main agreements on oceans, coasts and islands

Agenda 21 (1992)

Paragraphs 17.6(b): Each coastal State should consider establishing, or where necessary strengthening, appropriate coordinating mechanisms (such as a high-level policy planning body) for integrated management and sustainable development of coastal and marine areas and their resources, at both the local and national levels. Such mechanisms should include consultation, as appropriate, with the academic and private sectors, non-governmental organizations, local communities, resource user groups, and indigenous people. […]

Convention on Biological Diversity (1992)

Art. 6(b): Integrate, as far as possible and as appropriate, the conservation and sustainable use of biological diversity into relevant sectoral or cross-sectoral plans, programmes and policies.

Barbados Action Plan (1994)

Paragraph 23(a): Apply integrated coastal area management approaches, including provision to involve stakeholders, in particular local authorities and communities and relevant social and economic sectors, including non-governmental organizations, women, indigenous people and other major groups. Paragraph 26.A(i): Establish and/or strengthen, where appropriate, institutional, administrative and legislative arrangements for developing and implementing integrated coastal zone management plans and strategies for coastal watersheds and exclusive economic zones, including integrating them within national development plans.

Global Programme of Action for the Protection of the Marine Environment from Land Based Activities (GPA) (1995)

Paragraph 19: States should, in accordance with their policies, priorities and resources, develop or review national programmes of action within a few years and take forward action to implement these programmes with the assistance of the international cooperation identified in Chapter IV, in particular to developing countries, especially the least developed countries, countries with economies in transition and Small Island Developing States (hereinafter referred to as "countries in need of assistance"). The effective development and implementation of national programmes of action should focus on sustainable, pragmatic and integrated environmental management approaches and processes, such as integrated coastal area management, harmonized, as appropriate, with river basin management and land-use plans.

Code of Conduct for Responsible Fishing (1995)

Paragraph 6.9: States should ensure that their fisheries interests, including the need for conservation of the resources, are taken into account in the multiple uses of the coastal zone and are integrated into coastal area management, planning and develop-

ment. Paragraph 10.4.1: States should establish mechanisms for cooperation and coordination among national authorities involved in planning, development, conservation and management of coastal areas.

Plan of Implementation for the World Summit on Sustainable Development (2002)

Paragraph 29(e): Promote integrated, multidisciplinary and multisectoral coastal and ocean management at the national level, and encourage and assist coastal States in developing ocean policies and mechanisms on integrated coastal management.

Paragraph 29(g): Assist developing countries in coordinating policies and programmes at the regional and subregional levels aimed at the conservation and sustainable management of fishery resources, and implement integrated coastal area management plans, including through the promotion of sustainable coastal and small-scale fishing activities and, where appropriate, the development of related infrastructure.

In order to develop a common set of indicators for ICM, common goals of sustainable coastal and ocean development can be identified first. These can be defined as follows (Cicin-Sain and Knecht 1998):

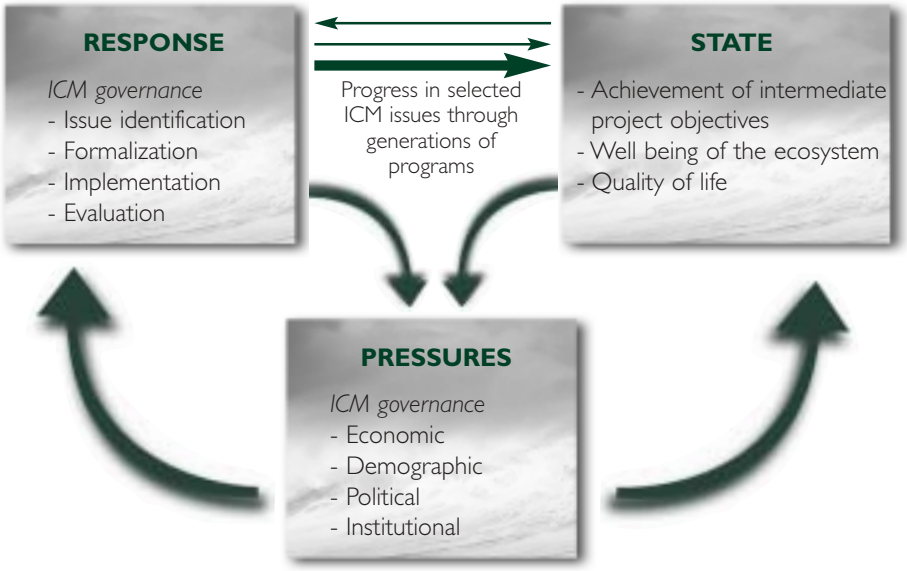
- Sustainable development of coastal and marine areas;
- Reducing vulnerability of coastal areas and their inhabitants to natural hazards;
- Sustainable well-being of coastal ecosystems;
- Sustainable quality of life in coastal communities;
- Improvement of governance processes.

To pursue the above goals, ICM performs a series of typical functions (Cicin-Sain and Knecht 1998):

- *Area planning*, to plan for present and future uses of coastal and marine areas and provide a long-term vision;
- *Promotion of economic development*, to promote appropriate uses of coastal and marine areas;
- *Stewardship of resources*, to protect the ecological base of coastal and marine areas, preserve biological diversity, and ensure sustainability of uses.
- *Conflict resolution*, to harmonize and balance existing and potential uses and address conflicts among coastal and marine uses;
- *Protection of public safety*, to protect public safety in coastal and marine areas typically prone to significant natural, as well as human-made, hazards; and
- *Proprietorship of public submerged lands and waters*, to, as governments are often outright owners of specific coastal and marine areas, manage government-held areas and resources wisely and with good economic return to the public.

The performance of ICM programs, therefore, can be assessed in terms of their ability to achieve the above goals and functions. In this respect, it is essential to define the causal relationships between an ICM program and the series of early, intermediate, and final outcomes it is supposed to achieve. ICM can be defined accordingly as a governance process framed into the Pressure-State-Response (PSR) framework (see Figure 2-1 below), acting as a series of integrated or coordinated responses aimed at managing human-induced pressures and thus improving the state of coastal communities and environments. The task of coastal indicators is to assess the effectiveness of ICM in this regard.

Figure 2-1 *The PSR framework and the ICM cycle (from Olsen 1997)*



At the national level, more specific goals for ICM or sustainable development of coastal and marine areas can be identified.

In *Canada*, the new Canadian Oceans Strategy (Government of Canada 2002a) aims to achieve a more integrated, sustainable management of Canada's oceans, addressing the different environmental threats posed to its long and varied coastline and optimizing its ocean governance system to reduce conflicts both between competing uses of the ocean and competent agencies. Based on the Oceans Act 1996, the Canadian Oceans Strategy (Government of Canada 2002b) will:

- Move to an integrated, comprehensive vision for ocean management;
- Optimize economic opportunities while considering social and environmental goals; and
- Involve Canadians in decision-making affecting Canada's three oceans.

In the *United States*, the Coastal Zone Management Act (CZMA) sets forth goals for coastal zone management related to, in particular: coastal wetlands; natural hazards; public access; deteriorating urban waterfronts and ports; public participation.

In the *United Kingdom*, the 1999 Strategy for Sustainable Development (UK Government 1999) identified the following objectives for seas, oceans, and coasts:

- Reduce or eliminate inputs of hazardous and radioactive substances of most concern;
- Aim to raise consistent compliance with the European Bathing Water Directive;
- Protect marine habitats and species;
- Improve the management and conservation of fish stocks; and
- Work with other countries to achieve effective management and conservation of fish stocks.

The need for ICM indicators as suggested by international guidelines

The international agreements mentioned in Box 2.2 all contain provisions relating to the monitoring and use of indicators. In the Law of the Sea, monitoring is mainly referred to as the control of the risks of pollution. In Agenda 21, the development and implementation of environmental quality criteria is called for, as well the assessment of environmental quality and socioeconomic conditions of coastal areas. In the Convention on Biological Diversity, monitoring is referred to in terms of the activities that might have adverse effects on the conservation of biodiversity. The Global Programme of Action assessment is also related to the effectiveness of programs and activities, in environmental, economic, and social terms.

Most international guidelines for ICM call for the use of indicators to monitor the state of the coastal zones and assess the performance of ICM efforts. The ICM guidelines developed by UNEP (1995) for the Mediterranean

Box 2-2 The role of indicators in the main agreements on oceans, coasts and islands

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

Art. 204, Monitoring of the Risks of Pollution:

1. States shall, consistent with the rights of other States, endeavour, as far as practicable, directly or through the competent international organizations, to observe, measure, evaluate and analyse, by recognized scientific methods, the risks or effects of pollution of the marine environment.
2. In particular, States shall keep under surveillance the effects of any activities which they permit or in which they engage in order to determine whether these activities are likely to pollute the marine environment.

Agenda 21 (1992)

Paragraph 17.6(n): Development and simultaneous implementation of environmental quality criteria [provided by national coordination mechanisms].

Paragraph 17.8(b): Develop socio-economic and environmental indicators; (c) Conduct regular environmental assessment of the state of the environment of coastal and marine areas [Collection and analysis of information on the state of resources].

Paragraph 17.68: Special support, including cooperation among States, will be needed to enhance the capacities of developing countries in the areas of data and information, scientific and technological means, and human resource development in order to participate effectively in the conservation and sustainable utilization of high seas marine living resources [Capacity building].

Convention on Biological Diversity (1992)

Article 7. Identification and Monitoring:

Each Contracting Party shall, as far as possible and as appropriate, in particular for the purposes of Articles 8 to 10: (a) Identify components of biological diversity important for its conservation and sustainable use having regard to the indicative list of categories set down in Annex I; (b) Monitor, through sampling and other techniques, the components of biological diversity identified pursuant to subparagraph (a) above, paying particular attention to those requiring urgent conservation measures and those which offer the greatest potential for sustainable use; (c) Identify processes and categories of activities which have or are likely to have significant adverse impacts on the conservation and sustainable use of biological diversity, and monitor their effects through sampling and other techniques; and (d) Maintain and organize, by any mechanism data, derived from identification and monitoring activities pursuant to subparagraphs (a), (b) and (c) above.

Barbados Programme of Action (1994)

Article 26(a)(ii): Design comprehensive monitoring programmes for coastal and marine resources, including wetlands, in order to determine shoreline and ecosystem stability, and also document and apply, as a basis for integrated coastal zone planning and decision-making, traditional knowledge and management practices that are ecologically sound and include the participation of local communities. [National action, policies and measures]

Article 26(c)(iv): Support Small Island Developing States in establishing national and regional capabilities for the effective surveillance and monitoring of activities within their exclusive economic zones, setting up regional and other joint-venture fishing enterprises, developing inventories of marine resources and regional approaches to the sustainable management of their exclusive economic zones, and strengthening regional marine research centres. [International action]

Article 29(a)(ii): Adopt appropriate standards for the management of freshwater resources, and develop and strengthen low-cost monitoring and assessment capabilities, linked to water resource databases, for relevant decision-making tools, including forecasting models for water management, planning and utilization.

Article 29(a)(iii): Strengthen procedures to monitor and respond to the impacts on water resources of natural and environmental hazards, in particular the impacts of climate change and climate variability, including drought and sealevel rise. [National action, policies and measures]

Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (1995)

Article 8: (a) Identification and assessment of problems [provisions in ICM plans].

Article 27: A key element in successful strategies and programmes is to develop ongoing means of determining whether they are meeting their management objectives. States should develop specific criteria to evaluate the effectiveness of such strategies and programmes. While such criteria must be tailored to the particular mix of elements (illustrated in section C above) in each strategy or programme, they should address: (a) Environmental effectiveness; (b) Economic costs and benefits; (c) Equity (costs and benefits of the strategy or programme are being shared fairly); (d) Flexibility in administration (the strategy or programme can adapt to changes in circumstances); (e) Effectiveness in administration (management of the strategy or programme is cost-effective and accountable); (f) Timing (the timetable needed to put the strategy or programme in place and to begin producing results); (g) Inter-media effects (the achievement of the objectives of the strategy or programme creates a net environmental benefit).

Code of Conduct for Responsible Fisheries (1995)

Article 6.10: Within their respective competences and in accordance with international law, including within the framework of subregional or regional fisheries conservation and management organizations or arrangements, States should ensure compliance with and enforcement of conservation and management measures and establish effective mechanisms, as appropriate, to monitor and control the activities of fishing vessels and fishing support vessels.

Article 7.7.3: States, in conformity with their national laws, should implement effective fisheries monitoring, control, surveillance and law enforcement measures including, where appropriate, observer programmes, inspection schemes and vessel monitoring systems. Such measures should be promoted and, where appropriate, implemented by subregional or regional

fisheries management organizations and arrangements in accordance with procedures agreed by such organizations or arrangements. [fisheries and vessels]
Article 9.1.5: States should establish effective procedures specific to aquaculture to undertake appropriate environmental assessment and monitoring with the aim of minimizing adverse ecological changes and related economic and social consequences resulting from water extraction, land use, discharge of effluents, use of drugs and chemicals, and other aquaculture activities. [aquaculture]
Article 10.2.5: States should promote multi-disciplinary research in support of coastal area management, in particular on its environmental, biological, economic, social, legal and institutional aspects.
Article 12.5: States should be able to monitor and assess the state of the stocks under their jurisdiction, including the impacts of ecosystem changes resulting from fishing pressure, pollution or habitat alteration. They should also establish the research capacity necessary to assess the effects of climate or environment change on fish stocks and aquatic ecosystems.

call for the use of indicators as part of databases for integrated coastal area management (ICAM). The guidelines also mention the use of environmental and socioeconomic indicators to create environment-development scenarios for the Coastal Area Management Programme (CAMP) for the Island of Rhodes. Similarly, the guidelines developed by UNEP for the Caribbean (UNEP/CEP 1996) include various types of indicators useful for ICM:

- Indicators of environmental condition ("state");
- Indicators of impacts on the environment ("pressures");
- Indicators of government program investment ("responses");
- Indicators of government program performance;
- Non-critical indicators or surrogate measures of environmental conditions;
- Episodic events or phenomena which may be indicative of changing environmental conditions;
- Economic indicators of wealth;
- Population and housing indicators; and
- Other social indicators.

In addition to the above indicators, an ICM program could rely on more specific indicators developed for the purposes of the initiative.

UNEP (UNEP/MAP/PAP 1999) has developed guidelines for Integrated Coastal and River Area Management (ICRAM), which contain recommendations on the use of indicators for ICM. In particular: (a) changes in the state indicators, framed in the context of the PSR model, are considered with reference to (b) the effects they produce on various uses functions, including use and non-use values; while (c) response and controlling actions by individuals, public and private bodies are assessed in terms of the effects of their interventions.

FAO (1998), has highlighted the need to monitor indicators for ICM, including physical parameters, biological and chemical parameters, and economic and social parameters. In addition, FAO underlined the need to develop evaluations of the performance of ICM programs, focusing on objectives and outcomes.

More recently, the European Union (EU) (Doody, Pamplin, et al. 1999) has emphasized that ICM indicators should be user-led and that research on indicators and decision support systems (DSS) should be more clearly linked to the needs of users and the results tested through practical application. This can be achieved by involving actors at project inception to decide which issues to monitor and to establish which indicators to assess and monitor the efficacy of policy and management actions.

2.2 Indicators model approaches and frameworks

Defining indicators

An indicator can be defined as (OECD 1993):

A parameter or a value derived from parameters, which provides information about a phenomenon. The indicator has significance that extends beyond the properties directly associated with the parameter value. Indicators possess a synthetic meaning and are developed for a specific purpose.

- They reduce the number of measurements and parameters which normally would be required to give an "exact" presentation of a situation. As a consequence, the size of a set of indicators and the amount of detail contained in the set needs to be limited. A set with a large number of indicators will tend to clutter the

overview it is meant to provide. Too few indicators, on the other hand, may be insufficient to provide the necessary relevant information. In addition, methodological problems related to weighting tend to become greater with an increasing level of aggregation;

- They simplify the communication process by which the information of results of measurement is provided to the user. Due to this simplification and adaptation to user needs, indicators may not always meet strict scientific demands to demonstrate causal chains. Indicators should therefore be regarded as an expression of "the best knowledge available."

Indicators useful for coastal management purposes can be distinguished into different types: Environmental indicators; Socioeconomic indicators; and Indicators to evaluate ICM efforts. These indicators are discussed separately in the respective sections.

Environmental Indicators and the Pressure-State-Response Framework

Environmental indicators reflect trends in the state of the environment, help the identification of priority policy needs and the formulation of policy measures, and monitor the progress made by policy measures in achieving environmental goals. Environmental indicators also represent a powerful means to communicate environmental issues not only to policy makers but also to the general public, thus raising awareness. Environmental indicators can be further distinguished into different types (Smeets and Waterings 1999).

Descriptive indicators describe the state of environment in relation to a series of environmental issues, such as eutrophication, loss of biodiversity, or overfishing. Indicators on driving forces express socioeconomic developments (for example, the growth rate of population in coastal areas) and trends in patterns of production and consumption (use of nitrate in agriculture) responsible for placing pressures on the environment (the release of nitrogen and phosphorus into coastal waters). State indicators help to measure the quantity and quality of localized physical and chemical phenomena in the environment and their evolution over time (the concentration of nutrients in coastal waters). Anthropogenic pressures are responsible for certain impacts on the environment (e.g., the growth of algae in coastal waters). Responses refer to the measures undertaken by society to change patterns of production and consumption (e.g., control of the use of nitrates in agriculture) and ultimately mitigate human impacts on the environment or restore environmental conditions.

Performance indicators compare actual conditions versus desired conditions, expressed in terms of environmental targets. Performance indicators, therefore, measure the "distance" to certain environmental targets and make institutions more accountable for their operation. Performance indicators can refer to a series of reference conditions and values, such as (a) national policy targets, (b) international policy targets accepted by governments, and (c) tentative approximations of sustainability levels. Targets of type (a) and (b) are often the result of compromise among different governments and constituencies and do not necessarily reflect sustainability considerations. The definition of sustainability levels is still in development and is not very advanced for coastal and marine issues, whereas ecosystem-based considerations are still to be incorporated into policy measures.

Alternatives to the PSR model include the PSR/effects model, developed by the U.S. Environmental Protection Agency (EPA), the PS/impact/R of the United Nations Environment Programme (UNEP), and the Driving forces/PS/impact/R framework adopted by the European Environment Agency (EEA).

As reported by a survey of the OECD (OECD 1997), most countries are currently monitoring a range of environmental quality parameters, typically physical or biological (e.g., in relation to the EU Bathing Quality Directive). Only in a few cases, indicators are developed for management processes, to assess whether current or projected uses of the coastal zone are sustainable. Most countries also include a chapter on coastal and marine issues in their periodic state of the environment reports.

Ecosystem-based approach

According to the CBD, the ecosystem approach can be defined as follows:

The ecosystem approach is based on the application of appropriate scientific methodologies, which focus on levels of biological organization and encompass the essential processes and interactions amongst organisms and their environment. The ecosystem approach recognizes that humans are an integral component of ecosystems.

It also recognizes the varying temporal scales and lag effects which characterize ecosystem processes. Objectives for ecosystem management should be therefore set for the long term. In management terms, the ecosystem approach recognizes that change is inevitable and should seek the appropriate balance between conservation and use of biological diversity. To

monitor change, this approach considers all forms of relevant information, including scientific and indigenous and local knowledge, innovations and practices and considers that all relevant sectors of society and scientific disciplines should be involved (CBD COP 1998).

Australia and Canada are championing the implementation of the ecosystem approach into their respective ocean policies. Australia's Ocean Policy, launched in 1999 is founded on ecosystem-based ocean planning and management system aimed at ensuring the maintenance of ecological processes, biological diversity and viable functioning populations of native species. The ecosystems-based approach is to be implemented through a regional marine planning process with the aim of improving linkages between different sectors and across jurisdictions. A national system of marine protected areas is to be the major component of the implementation. Within the Ocean Policy, the Science and Technology Plan will outline a series of indicators of ocean environmental health and integrity that will be developed in the context of a continuing program to complete a systematic mapping and exploration of marine ecosystems for the pursuance of their integrity. Requirements for monitoring, reporting and performance assessment will also be developed (Commonwealth of Australia 1999).

With the 1997 Oceans Act, Canada has established a framework for ocean resource management and marine environmental protection. The Oceans Act defines the areas that Canada proposes to manage and protect; establishes guiding principles and assigns the authority to negotiate partnerships for the development of an oceans management strategy; and consolidates and defines some oceans programs to improve the effectiveness of Canada's conservation and protection initiatives. The Oceans Act outlines a new approach to managing oceans and their resources. The concept is based on the premise that oceans must be managed as a collaborative effort among stakeholders and that ocean management should be based on the principles of sustainable development, integrated management of activities occurring in or effecting oceans, and the precautionary approach. In this context, the National Marine Indicator Working Group of Environment Canada has reviewed and identified categories of indicators of marine ecosystem health or integrity for five main categories: contaminants; pathogens, biotoxins, and diseases; diversity and size spectrum; primary productivity and nutrients; and instability. Ecosystem health parameters are monitored by national and regional programs, as well as by local and citizen-based initiatives, with an emphasis on contaminants. (EcoHealth Consulting. 2001).

2.3 The policy cycle of integrated coastal management and indicators

The typical ICM policy cycle can be conceived as a "loop" comprising a series of phases going from planning to implementation and delivery of outcomes, to monitoring and evaluation and adjustment of the program objectives and design (Figure 2.2). While indicators are often used in the evaluation phase, particularly in ex-post evaluations, the use of indicators to assess progress of ICM should be extended to all the other phases, in order to track advancements at different levels.

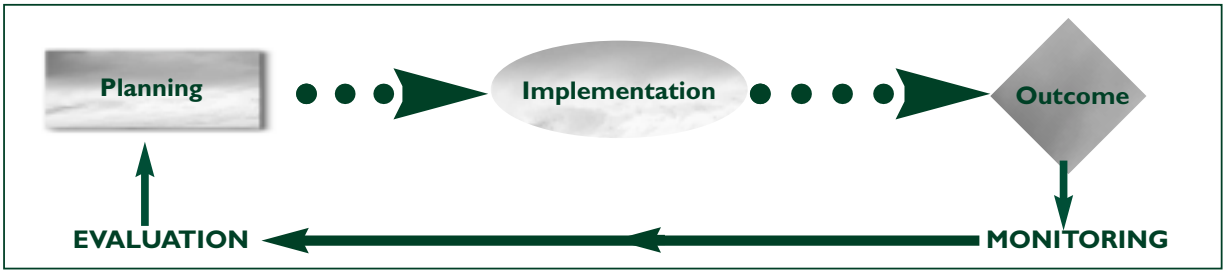
Indicators to evaluate the performance of ICM efforts

ICM efforts can be evaluated in different terms (Olsen, Lowry et al. 1999):

- Performance evaluations
- Management capacity evaluations
- Outcome evaluations

Performance evaluations. Performance evaluations are undertaken to assess the extent to which an ICM effort has been implemented and the quality of the implementation.

Figure 2-2. *The policy cycle of integrated coastal management*



The effort is assessed with a view to measuring whether it meets the requirements of the supporting institutions. Performance evaluation can also include an analysis of the successes and weaknesses of an ICM effort by distinguishing factors directly attributable to the intervention from those originated in a broader context as externalities (METAP 1998).

Management capacity evaluations. Management capacity evaluations are carried out to assess the adequacy of structures and processes to perform ICM tasks and activities. The evaluation can involve the assessment of the presence of a mission and strategy to achieve ICM goals, the availability of infrastructure and staff, the coverage of activities undertaken or completed, and the availability of sufficient financial resources (UNDP n.d.).

Outcome evaluations. Outcome evaluations aim at assessing the impacts of ICM efforts in environmental and socioeconomic terms. Outcomes can also be measured in terms of the degree of integration achieved by an ICM effort, both among sectors and levels of authority, as well as in terms of the integration of environmental and developmental factors, governance integration, and levels of public participation. The outcomes of an ICM initiative can also be measured in relation to its sustainability, either financial, institutional, or political (METAP 1998).

Typical shortcomings of outcome evaluations of ICM efforts have been identified (Olsen, Tobey et al. 1997) and can be summarized as follows:

- Adopting vague goals and targets;
- Choosing objectives that cannot be measured;
- Selecting indicators that identify efforts rather than outcomes; and
- Maintaining original objectives, ignoring change and a need for adaptation.

Other dimensions of ICM evaluation are evident when considering assessments of donor-driven initiatives. A survey carried out by the Coastal Resources Center (CRC) in 1997 among 19 donor institutions has identified the major issues that form the subject of donor evaluations (Lowry, Olsen et al. 2001):

- Human capacity
- Government commitment
- Participatory planning, decision making, and management
- Institutional structure
- Public education and awareness
- Sustainability
- Use of scientific information
- Clear roles and responsibilities
- Assessment of conditions and trends
- Policy framework / legislative mechanisms
- Conflict resolution
- Monitoring and evaluation
- Traditional attitudes, uses, and rights
- Transfer of knowledge / experience
- Issue analysis
- Public disclosure

Characteristics of indicators

Ongoing work on coastal indicators — for example in the EU in the framework of the activities of the European Environment Agency (EEA) — provides insight into the desirable characteristics of a system of indicators for ICM (Table 2-1).

Table 2-1 *Characteristics of indicators: The European example*

Relevance	Characteristics
Relevance to the coastal zone	• Indicators should be responsive to changes in environmental conditions (biological, geo-physical and/or chemical) in the coastal zone related to human activity • They should relate to functional concepts (ecosystem: food-web relations; human risk: safety) • The total list of indicators should be representative of the characteristics of the coastal zone; • The indicators should not overlap the state, pressure and impact categories
Relevance to European policy	• Indicators should show response elasticity (how easily could a decision-maker respond/reduce a particular pressure to improve the state and/or reduce the impact) • They should concern transboundary aspects (relating to human activities, pressures, states or impacts) within Europe • They should provide a basis for international comparisons on a European level • They should be simple and easy to interpret
Measurability/ data availability	• The data required to support the indicator should be measurable and should be readily available, or potentially so, at a reasonable cost /benefit level • The data required to support the indicator should be adequately documented and of known quality • The data required to support the indicator should be updated at regular intervals in accordance with reliable (and comparable) procedures • They should be capable of revealing trends over time (in the past and in the future)

Relevance	Characteristics
Exclusion of natural fluctuations	• There should be a threshold or reference value against which indicators can be compared so that users are able to assess the significance of values associated with them
Spatial aggregation	• It should be possible to aggregate an indicator over space and time
General	• Indicators should be well-founded in technical and scientific theory • They should lend themselves to linkage with economic models, forecasting and information models in a general way

Source: Peronaci 2000

A recent assessment of experiences with indicators in five U.S. coastal states (NOAA 2002, see references pg. 104) has detailed the characteristics of an ideal indicator as:

- *Meaningful* to external audiences;
- *Useful* for internal management;
- *Sensitive* (e.g., progress can be measured on a periodic basis);
- *Within agency's scope of control and/or influence*
- Representative of an "*outcome*" rather than an "output";
- *Stakeholder involvement* in development;
- *Practical* (e.g., cost does not exceed benefit);
- *Transferable* to regional and national "state of the coast" assessment; and
- *Consistent* in measurement.

Waltz (2000) and Meadows (1998) both provide a series of characteristics for environmental indicators that could apply also to other types of indicators (Table 2.2):

- Have an agreed, scientifically sound meaning;
- Be representative of an environmental aspect of importance to society;
- Provide information of value, and its meaning is readily understood;
- Have a sound and practical measurement process;
- Help focus information to answer important question; and
- Assist decision-making by being effective and cost-efficient to use.

Good sustainability indicators should:

- Be relevant to sustainability—they must be symbolic tests of sustainability by showing linkages between the economic, social and environmental conditions (with a specific emphasis on environmental sustainability);
- Reflect environmental conditions, pressure on the environment as well as environmental management practices that are adopted to deal with these issues;
- Be simple and easy to interpret to be able to show changes that have occurred within the environment over time;
- Be understood and accepted by the community—they are understood to be a true reflection of sustainability; and
- Be comparative—they must be statistically measurable.

Table 2-2 *Requirements for indicators*

Scientific	Functional	Pragmatic
• Clear in value - showing no uncertainty in which direction is good and which is bad • Clear in content - presenting easily understandable units that make sense • Appropriate in scale - not over or under aggregated • Hierarchical - in order for a user to delve down into the details that are necessary	• Policy relevant - for all stakeholders in the system, including the least powerful • Compelling - interesting, exciting and suggestive of effective action • Sufficient - not too much information to comprehend but adequate to provide a suitable picture of the situation • Leading - so that they can provide information to act on	• Feasible - measurable at reasonable cost • Tentative - so that they are up for discussion, learning and change • Timely - compilable without long delays • Democratic - people should have input to indicator choice and have access to results • Participatory - make use of the information that people can measure for themselves

2.4. Geographic and time scales

For the selection and use of indicators, their geographical scale must be taken into account. Most indicators are conceived for the national level (see, for example, the UN sustainable development indicators). Others can be useful at smaller scale, either subnational (e.g., at the level of coastal counties, regions, or departments) or local (e.g., a coastal strip of 10 km inland and 12 km seaward). Other indicators are useful at the level of "hot spots". A discussion of the different geographical scales to which indicators can be applied is given by BP (UNEP, MCSD et al. 2001). In Europe and the Mediterranean, for example, information at the level of the coastal regions is collected at the 3rd level of the Nomenclature of the Statistic Territorial Units (NUTS), a classification system introduced in the 1970s.

The time scale can refer to the frequency at which information on indicators is collected. This can coincide with the period of a civil year. Some information can be collected with the same frequency at which the state of the environment reports are prepared, for example every two years. More in-depth information can be collected on a five-year basis (NOAA 2002 b).

2.5 Summary

The practice of ICM is driven by common goals of sustainable coastal and ocean development and is characterized by typical functions in pursuit of these goals. The extent to which ICM programs achieve these goals needs to be assessed in a systematic way that would allow the drawing of information and lessons learned for the improvement of ICM practice.

International guidelines prescribing ICM as the preferred approach to coastal and ocean management also call for the use of indicators in assessing progress achieved.

Indicators can provide an extremely useful way to improve communication, transparency, effectiveness and accountability in integrated coastal management. They are tools that can be used to clarify assessments of, and comparisons between, management programs through time. More importantly, they simplify the description of the extent to which the objectives for the management program are being achieved. Various types of indicators have been developed including environmental, socioeconomic, and governance indicators. These general types of indicators can fit in the framework of models and approaches of ICM, including the PSR and the ecosystem approach. Specific indicators under these broad categories can be formulated, depending on the issues that a program is addressing at the appropriate level and scale, at the beginning of the ICM process. As the program is implemented, monitoring of these indicators will be used to assess progress and to bring this information back into the planning process. Selection of indicators involves various considerations including: scientific validity; feasibility and cost-effectiveness in terms of their information collection demands; and ease in understanding.

3. The state of the coastal and marine environment: environmental indicators

3.1 Introduction

Indicators provide an extremely useful way to improve communication, transparency, effectiveness and accountability in natural resource management (including, integrated coastal management). They are a tool that classifies assessments of and comparisons between management programs through time. More importantly, they simplify the description of the extent to which the objectives for the management program are being achieved. As delineated in the previous chapter, the selection of indicators involves a number of considerations including: the need for indicators to be scientifically valid (i.e., the indicator is indicative of the objective they are intended to reflect and utilizes the "best scientific information available"); the need for them to be feasible and cost-effective in terms of their information collection demands; and the need to be easily understood.

Much work has been done at the global, regional, national and local (project and program) levels in the use and development of environmental indicators for each of the sectors that contribute to an integrated coastal management program (e.g., marine pollution, marine fisheries, biodiversity, etc.). This chapter looks at select cases of these various initiatives, from the global level (e.g., Organization for Economic Cooperation and Development) to the local level (e.g., Kent County, United Kingdom).

3.2 Selected examples of environmental indicators used at the global level

At the global/international level, there have been several initiatives to measure the status of the coastal and marine environment. The following discussion focuses on the major efforts in this field by the Commission on Sustainable Development (CSD), the WSSD, the UNEP, the Organization for Economic Cooperation and Development (OECD), the World Resources Institute (WRI), and the Global Ocean Observing System (GOOS).

The Commission on Sustainable Development

Since the 1992 Earth Summit, particular attention has been paid to developing and implementing a set of indicators that would measure sustainable development on the national, regional and global levels. After the CSD approved the Programme of Work on Indicators of Sustainable Development in 1995, it called upon UN, intergovernmental, and non-governmental organizations to implement the Programme's key elements, including a working list of 134 indicators.

The CSD organized the list of indicators according to the themes/chapters of Agenda 21 under the four primary dimensions of sustainable development (social, economic, environmental and institutional). Within the themes, the indicators were further classified according to their PSR characteristics. Under Chapter 17 of Agenda 21, three driving force indicators and two state indicators were identified to monitor progress on the "Protection of the oceans, all kinds of seas and coastal areas." Table 3-1 outlines the revised core set of indicators for Oceans and Coasts that are within the capabilities of most countries to develop on the national level.

Table 3-1 *Revised CSD Indicators for Oceans and Coasts under Agenda 21*

Theme	Sub-theme	Indicator
Oceans, Seas and Coasts (17)	Coastal Zone	Algae concentration in coastal waters
		Percent of total population living in coastal areas
	Fisheries	Annual catch by major species

Source: UN

The five year Work Programme on Indicators of Sustainable Development concluded in 2000 and resulted in a report entitled *Indicators of Sustainable Development: Guidelines and Methodologies* (United Nations 2001). It is the finalized version of the proposed framework and the core set of indicators to assist member countries in measuring their progress towards sustainable development. Examples of preliminary results from the 1997 Special Session of the General Assembly to Review and Appraise the Implementation of Agenda 21, regarding Chapter 17 can be found at http://www.un.org/esa/earthsummit/ga97nat.htm.

Some successful lessons that emerged from the evaluation of the testing results and indicator set, include a heightened awareness of the value and importance of indicators, increased levels of understanding on sustainable development issues, and stronger organization of national coordinating mechanisms through the use of existing structures (e.g., national committees or councils for sustainable development).

In this instance, constraints were encountered in the institutional implementation of the testing process and the applicability of the indicator framework. Institutional constraints included limited financial, time and human resources, lack of coordination between agencies, lack of awareness among stakeholders, and insufficient institutional commitment. Some countries concluded that the driving force-state-response framework was inappropriate for the social, economic, and institutional dimensions of sustainable development. Additionally, gaps in the framework where appropriate indicators were unavailable hindered the selection of national indicator sets, especially with respect to response indicators. The general reaction to the CSD framework was that the working list of indicators was too long, making it difficult to test and develop all indicators in a national context.

The Plan of Implementation for the World Summit on Sustainable Development

The World Summit on Sustainable Development (WSSD), held in Johannesburg from 26 August to 4 September 2002 ended with the commitment of 100 governments to a number of actions, that are targets and deadlines, very relevant to integrated ocean and coastal management (Table 3-2).

Table 3-2 *Targets, actions and deadlines called for by the Plan of Implementation for the World Summit on Sustainable Development*

Area	Actions	Deadline
Integrated ocean and coastal management	Encouraging the application of the ecosystem approach for the sustainable development of the oceans, particularly in the management of fisheries and the conservation of biodiversity Establishing an effective, transparent and regular inter-agency coordination mechanism on ocean and coastal issues within the United Nations system	2010
Fisheries	Implementing the FAO International Plan of Action to Prevent, Deter and Eliminate Illegal, Unreported and Unregulated Fishing	2004
	Implementing the FAO International Plan of Action for the Management of Fishing Capacity	2005
	Maintaining or restoring depleted fish stocks to levels that can produce their maximum sustainable yield	On an urgent basis and where possible by 2015
	Eliminating subsidies that contribute to illegal, unreported and unregulated fishing and to overcapacity	

Area	Actions	Deadline
Conservation of biodiversity	Developing and facilitating the use of diverse approaches and tools, including the ecosystem approach, the elimination of destructive fishing practices, the establishment of marine protected areas consistent with international law and based on scientific information, including representative networks	2012
Reduction of marine pollution	Advancing implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based activities in the period 2002-2006 with a view to achieve substantial progress	2006
Science and observation	Establishing a regular process under the United Nations for global reporting and assessment of the state of the marine environment, including socioeconomic aspects	2004
Small Island Developing States	Developing community-based initiatives on sustainable tourism in Small Island Developing States	2004
	Reducing, preventing, and controlling waste and pollution and their health-related impacts in Small island developing States through the implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities	2004
	Supporting the availability of adequate, affordable and environmentally sound energy services for the sustainable development of small island developing States, including through strengthening efforts on energy supply and services	2004
	Undertaking a comprehensive review of the implementation of the Barbados Programme of Action for the Sustainable Development of Small Island Developing States	2004

The achievement of such targets will require the development and use of indicators to monitor and demonstrate progress and results in a comparable way across countries, regions, and project portfolios. The Plan of Implementation also recommends to:

> Promote integrated, multidisciplinary and multisectoral coastal and ocean management at the national level, and encourage and assist coastal States in developing ocean policies and mechanisms on integrated coastal management (paragraph 29[e]).

The emphasis on the need to foster ICM at the national level is relevant in that it implicitly recognizes the inherent limitations of approaching ICM only through small-scale or demonstration project at the subnational level and calls for national guidance and coordination.

UNEP Global Environment Outlook GEO-3

The latest (Global Environment Outlook) GEO-3 report, released in 2002 by the United Nations Environment Programme (UNEP), provides an overview of environmental and development issues with a retrospective of thirty years. The report presents a review and policy analysis of key environmental issues at global and regional levels, including coastal and marine issues. It also discusses the increasing vulnerability of people due to environmental degradation and disasters and presents a range of policy actions aimed at strengthening the environmental pillar of sustainable development.

GEO-3 is accompanied by an online data compendium and data portal, available at http://unep.net. Fourteen indicators, roughly compiled within the three main types of indicator classes are provided for under the theme "Coastal and Marine Areas," (Table 3-3).

Table 3-3 *Indicators for oceans and coasts in the GEO-3 report*

Type of indicator	Indicators
Environmental aspects	• Aquaculture production • Crustaceans and mollusks catch - marine • Fish catch • Fish catch - marine • Fishery production • Population within 100 km of the coast
Socioeconomic aspects	• Length of coastline • Threats to reefs
Governance aspects	• Claimed exclusive economic zones (EEZ) • Continental shelf area • Exclusive fishery zones (EFZ) • Marine protected areas (IUCN category I, VI)–area • Marine protected areas (IUCN category I, VI)–number • Territorial sea

Source: http://unep.net

Emphasis is on jurisdictional aspects (maritime claims) as well as on sustainable development indicators: environmental state indicators (threats to reefs), pressure indicators (coastal population, fish catch), and policy response indicators (marine protected areas).

Data sets are available on national, regional, and subregional levels, for variable time periods ranging from thirty years (aquaculture production, 1970-1999) to one year (length of coastline, 2000).

The Organization for Economic Cooperation and Development

The OECD conducted two studies related to environmental indicators. The first is a general report on environmental indicators, the OECD Core Set of Indicators for Environmental Performance Review. The second is a more specific report for integrated coastal zone management indicators, *Integrated Coastal Zone Management: Review of Progress in Selected OECD Countries* (OECD 1997).

The OECD Core Set of Indicators for Environmental Performance Review

In 1989, an OECD council made the first demand for environmental indicators. This demand was later reiterated in 1991 and by member countries. The goals of the OECD in developing environmental performance indicators included producing a common framework and terminology for indicators, creating general guidelines for the use of indicators and producing a core set of indicators (ranked with respect to data availability and measurability). The OECD framework was based on the PSR model.

The OECD framework core set of indicators was structured around the fourteen environmental issues considered most problematic. The issues are categorized according to whether the issue deals with environmental quality ("sink-oriented," issues 1-9 and 14) or to the quantity of natural resources ("source-oriented," issues 10-13). The OECD indicators are also categorized according to their temporal measurability, i.e., short-term, mid-term, or long-term. Table 3-4 provides a summary of short-term indicators at the international level by environmental issue.

The criteria used to select these core indicators include:

- Policy relevance and utility for users—representative picture, easy to interpret, responsive to changes, international comparisons, national in scope, and threshold or reference value;
- Analytical soundness—well founded, international consensus, and linked to economic models, forecasting and information systems; and
- Measurability—available at a reasonable cost-benefit ratio, adequately documented, and regularly updated.

The OECD's drive and will to produce such a set of environmental indicators is the primary strength of this initiative. While the development of this set has furthered the field of indicator research, some limitations are evident in its effect. Foremost, problems were encountered with data availability. Secondly, there were problems relating to the identified indicators with the thirteen issues; one-to-one correspondence between indicators and issues was not always apparent. During this process, OECD found that not every area of assessment lends itself to quantitative information; certain policy areas may be assessed in qualitative terms. France's experiences with the core set of indicators are detailed in the National Level Initiatives section of this chapter.

Table 3-4 *Examples of short-term indicators by environmental issues*

Issues	Indicators of environmental pressures	Indicators of environmental conditions	Indicators of societal responses
Eutrophication	Apparent consumption of fertilizers, measured in N, P	BOD, DO, N and P in selected rivers	% of population connected to waste-water treatment plants
Biological diversity and landscape	Land use changes	Threatened or extinct species as % of known species	Protected areas as % of total area
Fish resources	Fish catches		

Source: OECD 1993

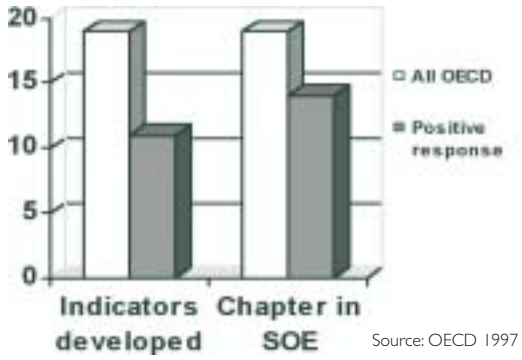
Integrated Coastal Zone Management: Review of Progress in Selected OECD Countries

This report focuses more on the degree to which OECD countries have implemented ICZM programs based on survey research carried out during 1995 and 1996 (OECD 1997). Because this study focuses more on the policy objectives and integration and policy instruments of individual countries' ICZM programs, it will be discussed further in Chapter 5, Governance Indicators.

The OECD survey was sent to its 30 member countries; 19 countries and the European Commission responded to the survey. In the survey, two questions inquire about the status of environmental indicators and their implementation:

- Have coastal environmental indicators been developed? If yes, are these indicators monitored on a regular basis?
- Is there a specific section on coastal resources or the coastal zone in a regularly published state of the environment report?

Figure 3-1 *Status of development and implementation of environmental indicators*



Source: OECD 1997

Of the 19 countries that responded, 11 said coastal indicators had been developed (Figure 3-1). Fourteen countries answered that there is a specific section for coastal resources and the coastal zone in the state of the environment report.

Case studies of indicators from this report include those from the Netherlands and the European Union. The Netherlands' environmental indicators include a base coastline, water quality criteria, functional areas in dune ecosystems, bathing water quality standards, shellfish water quality standards and a biodiversity indicator. The environmental indicators listed from the European Union include bathing water quality and shellfish water quality.

From this survey, it can be concluded that indicators for integrated coastal zone management were only partially implemented up to 1996.

World Resources Institute

The World Resources Institute has conducted a Pilot Analysis of Global Coastal Ecosystems (PAGE). Its main objectives are to synthesize previous assessments for five major categories of ecosystems, including coastal ecosystems, identify information gaps, and support the launch of a Millennium Ecosystem Assessment.

Pilot Analysis of Global Coastal Ecosystems

The PAGE study of coastal ecosystems analyzed both quantitative and qualitative information from global and regional data sets, national assessments, and case studies in order to develop select indicators on the world's coastal zone (while the analysis did not include the continental slope and deep-sea habitats, it did include marine fisheries). Due to the general lack of global data on coastal habitats the analysis focused much of its efforts in identifying data and information gaps.

The rest of its efforts were devoted to developing useful, but often by proxy, indicators to assess the condition of goods and services derived from coastal ecosystems. In addi-

tion to the extent and change of the coastal zone, five categories of goods and services derived from coastal ecosystems were considered: shoreline stabilization, water quality, biodiversity, food production (marine fisheries), and tourism and recreation. The indicators developed for each category are listed in Table 3-5.

Table 3-5 *PAGE categories and indicators*

Category	Indicators
Extent and change of the coastal zone	• Coastal zone extent • Characterization of natural features • Extent of natural habitats • Loss of natural habitats • Natural versus altered land cover within 100 km of coastline • Human population within 100 km of coastline • Disturbance to benthic community - distribution of trawling grounds
Shoreline stabilization	• Natural versus altered land cover within 100 km of coastline • Beach area/profile • Severity and impact of natural hazards • Vulnerability to erosion and coastal hazard • Low-lying areas
Water Quality	• Eutrophication parameters • Harmful algal bloom events • Global occurrence of hypoxic zones • Shellfish bed closures • Beach closures • Beach tar balls • Persistent organic pollutants and heavy metal accumulation in marine organisms • Oil spills (frequency and volume) • Solid waste accumulation on beaches
Biodiversity	• Species richness • Conservation values • Threatened species • Habitat degradation--coral bleaching • Threats to habitat • Threats to ecosystem structure
Food production--Marine fisheries	• Analysis of the condition of fish stocks • Commercial harvest of important fish stocks • Percentage change in catch from the peak year • Change in trophic composition of fish catch
Tourism and recreation	• Value of tourism and employment in the tourism sector • Importance of tourism to the economy • Tourist arrivals • Equitable distribution of tourism benefit--leakage of tourism revenue

The limited availability and inconsistencies of the data in the page study hampered analysis efforts; therefore evaluation was heavily reliant upon expert opinion. Information needs for each category of goods and services are detailed in Box 3-1. The lack of information is exacerbated by the partitioning within disciplines into separate entities, e.g., the field of ecology is separated into terrestrial ecology, wetland ecology, and marine ecology. The separation among disciplines (i.e., among physical, chemical and social sciences) is even greater, hindering integrated analyses in an arena that is cross-sectoral and complex.

Estimates of the PAGE coastal ecosystem assessment are limited by the lack of comprehensive information regarding:

- The impacts of fishing, deforestation, and agricultural activities;
- Human activities beyond 60 kilometers of the coast;
- The relative sensitivities of different ecosystems to disturbance;
- Uncertainty of data quality; and
- The absence of cumulative effects in data modeling and mapping

Box 3-1 Information needs for each category of the PAGE Coastal Ecosystem Assessment

Extent and change of the coastal zone

- Information on the location and extent of coastal ecosystems is very incomplete and inconsistent at the global level.
- Historical data describing previous extent of habitats, against which we might hope to measure change, are very limited. Where no historical data exist, the possibility of predictive mapping should be considered, using existing climatic, oceanographic, and topographic data combined with biogeographic information.
- There is an urgent need for better and more consistent classification schemes and data sets characterizing the world's coasts. Particular effort needs to be focused on mapping the distribution of sandy and rocky shores, salt marshes, seagrasses, tidal mudflats, and lagoons.
- Coastal habitats occur over relatively small spatial units, are often submerged, and are, therefore, difficult to assess with the coarse-scale global sensors often used for other terrestrial ecosystems. High-resolution remote sensing capabilities in this area are improving rapidly, but are not yet being widely applied.
- The effects of human disturbances to ecosystems, such as trawling, are poorly documented. More accurate evaluation of impacts will require higher resolution data as well as site exploration.

Shoreline stabilization

- The function of shoreline stabilization provided by many natural coastal features is not well documented quantitatively.
- Data on conversion of coastal habitat and shoreline erosion are inadequate.
- No comprehensive data are available to assess shoreline change or sediment flows.
- Because of the dynamic character of the natural processes acting upon the shoreline, and because humans have often responded in an equally dramatic way, it is difficult to distinguish natural from human-induced changes.
- Information on long-term effects of human modifications on shorelines is lacking.
- Non-monetary measures of severity and damage from natural hazards are anecdotal.
- Sea level rise and storm effects resulting from climate change are speculative.

Water quality

- Global data on extent and change of key coastal habitats, such as wetlands and seagrasses, are not available.
- Many national and regional monitoring programs exist for a variety of pollutants, but the completeness and accuracy of data collected varies. Standardized sampling methodologies and parameters are necessary for making comparisons on a global basis.
- Increased direct monitoring of water quality parameters, coupled with using satellite sensors, can greatly improve our knowledge of the condition of the world's coastal waters.
- Current information relies heavily on anecdotal observations of extreme events, such as HABs, and not on continuous monitoring.
- More than 70,000 synthetic chemicals have been discharged into the ocean, and only a small percentage of these have been monitored—typically by human health standards, and not by ecological impact.

- Runoff and routine maintenance of oil infrastructure are estimated to account for more than 70 percent of the total annual oil discharge into the ocean, but actual data regarding such nonpoint sources are not available.

Biodiversity

- Information on the distribution of remaining natural coastal habitats is only available for some areas. Detailed maps are particularly lacking for submerged habitats, such as seagrasses, coral reefs, salt marshes, and tidal mudflats.
- Loss of coastal habitats (such as mangroves or wetlands) is reported in many parts of the world, but little is documented quantitatively.
- Species diversity is not well inventoried and population assessments are only available for some keystone species, such as sea turtles and whales.
- Available information on the distribution of species needs to be consolidated and integrated with information on habitat distribution.
- Information on invasive species is limited because of difficulties in identifying and inventorying them. Assessing their impact on the native ecosystem is also necessary but currently lacking.
- Limited information is available on the condition of ecosystems at the habitat level. For example, anecdotal observations are available for the world's coral reefs, reflecting coral bleaching, disease, and human impacts, but little data have been compiled on coral condition, such as change in live coral cover.
- Indicators of change in ecosystem structure have not been fully explored.

Food production – Marine fisheries

- FAO fisheries production statistics are limited to providing proximate information on commercial fish population trends and are, therefore, insufficient to assess the capacity of coastal and marine ecosystems to provide food.
- The FAO database on marine fisheries landings is the most complete data set at the global level; however it has important limitations. Some of the main problems are that much of the catch is not reported at the species level, particularly in the Indian Ocean and Central Pacific, and the subsistence and smallscale fisheries sector is underrepresented in the data collection efforts.
- Catch statistics are also biased as a result of unreported discarding, misreporting of harvests, and exclusion of all information on illegal fishing.
- Data are fragmentary on how many boats are deployed, and how much time is spent fishing, which obscures the full impact of fishing on ecosystems.
- No comprehensive data are available for average fish size, which would help in the assessment of the condition of particular fish populations.
- More extensive stock assessments are necessary to identify Maximum Sustainable Yield (MSY) for various commercially important species.

Tourism and recreation

- Not all countries report tourism statistics, and typically, only national data on tourism are available, rather than data specific to the coastal zone.
- Comprehensive information on the environmental and socioeconomic impacts of tourism is not available or is documented only qualitatively.
- No standard measure of tourism intensity exists.
- Information on the benefit of tourism to the local economy is very limited.
- Marine protected areas and tourism certification programs could help in collecting useful information on the value of nature-based tourism and the degree of benefits and impacts of overall tourism development to the local people and economy.
- A few tourism certification programs with varied criteria exist but no comprehensive data are available.
- The importance of assessing local capacity to physically and socially accommodate tourism development has been acknowledged. However, no standard indicator to measure this capacity has been developed.

The Millennium Ecosystem Assessment

The Millenium Ecosystem Assessment (MEA) is a "multi-scale" assessment; its design focuses on ecosystem services, the consequences of changes in ecosystems for human well being, and the consequences of changes in ecosystems for other life on earth. Guided by a Conceptual Framework, four Working Groups (under the categories of Sub-Global, Condition and Trends, Scenarios, Response Options) are tasked with the scientific work of the Millennium Assessment (MA). These Working Groups are co-chaired by natural and social scientists from developed and developing countries. These eight co-chairs and four other experts comprise the Assessment Panel. In addition to the four working groups, the MA secretariat coordinates a set of Engagement and Outreach activities designed to ensure that the needs of the "users" and stakeholders in the MA are reflected in the design and that the findings reach their intended audience.

The MEA Conceptual Framework and Design prepared by the Millennium Assessment Panel was approved by the MEA Board during its second meeting, January 14 – 16, 2002, in Malaysia. The MEA design focuses on ecosystem services (e.g., food, water, fiber), the consequences of changes in ecosystems for human well being, and the consequences of changes in ecosystems for other life on earth. The Conceptual Framework report is under development and is designed to set the stage for global assessment and to provide guidance for the MEA sub-global assessments. The MA will formally include any activity that is aligned with the essential criteria developed by the Sub-Global Working Group. Sub-global coastal ecosystem assessments have thus far been approved in Norway, Sweden, India, and the Small Islands of Papua New Guinea. No sub-global assessments have been approved for Oceans ecosystems.

The basic components of any ecosystem assessment involve the condition (including trends and driving forces), scenarios, and response options of the particular ecosystem under study (similar to the PSR models). Assessment of the ecosystem condition includes a core set of three to five ecosystem goods and services, plus site-specific services particular to that area. The goal of measuring capacity of ecosystems to maintain production of services distinguishes the MEA from assessments aimed at producing snapshots of production. Due to the differences between ecosystems, no single list of indicators will represent core services for all ecosystems; MEA requires that each assessment use appropriate indicators for each core ecosystem good or service, and provide a rationale for the indicators to be used, and the mechanisms for interpreting the indicators.

Each of the sub-global assessments will be overseen by a Steering Committee (SC) that assumes certain responsibilities. Each SC will have a clear Terms of Reference and measurable indicators of success, which in turn would relate directly to the indicators of success of the MEA. Those indicators include: (a) application of assessment findings in decision-making processes; (b) establishment or strengthening of networks; (c) leveraging of additional funds; (d) increasing capacity in the regions; (e) increasing public awareness; and (f) contributing to the global assessment.

In the formative stages, the MEA will focus on a small number of integrated multi-scale assessments in two to three focal regions through which to develop and test a set of internally consistent multi-scale methodologies for integrated ecosystem assessments. Two multi-scale integrated assessments have been proposed in Southern Africa and Southeast Asia, with a third in an industrialized region, such as Northern Europe, to be added during the first year of the MA process possibly a fourth in Central America.

Ecosystem "indicators" that are most readily available, provide only a partial description of the bigger picture. These indicators include: pressures on ecosystems, including such factors as population growth, increased resource consumption, pollution, and over-harvesting; extent of ecosystems; and production or output of various economically important goods by the system, such as crops, timber, or fisheries production. Each of these indicators is important, but collectively they provide only a narrow window on the question of how well ecosystems are being managed. Few traditional indicators provide information on the underlying condition or health of the ecosystem—its capacity to maintain the production or supply of goods and services important for human development.

One reason for the absence of sound indicators for ecosystem condition is the highly site-specific qualities of ecosystems. Consequently, for much of the world, the information needed for an accurate assessment of ecosystem condition is unavailable or incomplete. Where data is available, scientific understanding is sometimes insufficient to understand how changes in biological systems will affect the goods and services produced.

Earth Trends

WRI has also developed an environmental information portal (http://earthtrends.wri.org) including coastal and marine ecosystems. The portal contains five main categories of information: a searchable database; a series of data tables; country profiles; maps; and outstanding features. Data sets can be broken down by country or grouped by region, level of development, and level of income. The data provided can be classified according to the three main categories of indicators, as follows (See Table 3-6).

Table 3-6 *Indicators in the Earth Trends database*

Types of indicator	Indicators
Environmental indicators	• Coastline length • Mangrove forest area • Mangrove species, number • Scleractinia coral genera, number • Seagrass species, number
Socioeconomic indicators	• Aquatic plants, production • Aquatic plants, aquaculture production • Cephalopod production • Crustacean production, marine • Crustaceans, aquaculture production • Decked fishery vessels, number • Demersal fish production • Diadromous fish production • Diadromous fish, aquaculture production • Fish and fishery products, total food supply • Fish and fisheries: people employed in fishing and aquaculture • Fisheries: total aquaculture production • Fisheries: total freshwater capture • Fisheries: total marine capture • Marine fish, aquaculture production • Meals and soluble, exports • Meals and soluble, imports • Mollusk and crustacean catch • Mollusk production (excluding Cephalopods) • Mollusks and crustaceans, export • Mollusks and crustaceans, import • Mollusks, aquaculture production • Nutrition: annual food supply per capita from fish and fishery products • Nutrition: daily food supply per capita from fish and fishery products • Nutrition: fish protein as a percentage of total animal protein supply • Nutrition: fish protein as a percentage of total protein supply • Oil and fats, export • Oil and fats, import • Pelagic fish production • People actively fishing, number • Population within 100 km of the coast • Total marine production • Trade in fish and fisheries products: export value, all species • Trade in fish and fisheries products: import value, all species
Governance indicators	• Claimed Exclusive Economic Zone, area • Continental shelf area • Disputed territorial sea, area • Exclusive fishing zone, area • Territorial sea area

The dataset focuses on socioeconomic data, with a strong emphasis on fisheries. It provides data across a period of up to fifty years and can be searched by country, region, variable, and year. Based on the *World Resources Report*, a series of four data tables are also provided including some of the most relevant variables to capture environmental and socioeconomic phenomena: (1) coastal statistics, coastal biodiversity, and trade in coral; (2) marine and freshwater catches and aquaculture production; (3) marine fisheries, yield, and state of exploitation; and (4) trade in fish and fishery production, fish consumption, fishers and fleet information. The same information is organized into country profiles for each coastal state. Maps are provided for a number of priority or outstanding issues: beach tar observations in Japan (1975-1995), coral bleaching events and sea surface temperature anomalies, global occurrence of hypoxic zones, known trawling grounds of the world, natural coastal features, natural versus altered landcover within 100 km of the coastline, periods of peak fishery catches and decline, population distribution within 100 km of the coastline, shellfish bed closures in the Northeast United States, and threatened marine important bird areas in the Middle East.

The Global Ocean Observing System

The Global Ocean Observing System (GOOS) is a permanent global system for observing and analyzing marine and ocean variables to support ocean services worldwide. Established in 1991, the GOOS model has grown out of a vision to understand and forecast climate change to encompass all aspects of ocean management as well as climate change. GOOS is envisioned as a global network that systematically acquires and disseminates data and data-products in response to the needs of governments, industries, scientists, educators, non-governmental organizations, and the public for information on marine and estuarine environments. It is designed as a user-driven monitoring, assessment and analysis system that, at maturity, will include both ecosystem and socio-economic indicators.

Serving three main classes of user groups (operational users, data managers, and researchers), GOOS has ten general categories of applications:

- Operational marine coastal and ocean short range forecasting and analyses;
- Seasonal-to-interannual climate prediction;
- Numerical weather prediction;
- High-quality procedures for climate products;
- Biodiversity and habitat;
- Natural and man made hazards;
- Environmental indices;
- Fisheries productivity;
- Satellite data processing systems; and
- Regional, integrated systems.

GOOS operates through two modules:

- A basin-scale module focusing on the role of the ocean in the earth's climate system; and
- A coastal module focusing primarily on physical (and some biological) environmental changes in coastal, marine and estuarine ecosystems.

The coastal module represents a global network, regionally enhanced, for the measurement of common variables to detect and predict changes in coastal systems. Implementation adopts a stepwise process based on current priorities and capabilities, while emphasizing coordinated development of regional observing systems that require national and regional cooperation, coordination and collaboration.

The intended design of the coastal module of GOOS aims to operationalize an integrated and sustained observing system that provides effective linkages between measurements and data analysis for efficient access to data and delivery of environmental information. The strength of such a system, as described by Malone (2001) would lie in its ability to link user needs to measurements in order to form an end-to-end, user-driven system that requires a managed, two-way flow of data and information among three essential subsystems:

1. The monitoring subsystem that: (a) measures the required variables on the required time and space scales to detect and predict changes in core coastal indicators including meteorology, physical oceanographic variables, surface conditions, turbidity and sediment, dissolved nutrients, phytoplankton and clarity; and (b) requires the synthesis of data from remote sensing and in situ measurements.
2. The communications network and data management subsystem. A hierarchical system of local, national and supra-national organizations to provide data, information, and access to users at each level. Regional Information Centers (RICs) will have the potential to provide highly processed products for substantial data sets. This subsystem has first priority for development.
3. The data assimilation, analysis and modeling subsystem to increase the accuracy of state variables, test (integrative) models, and initialize operational models

defining changes in ecosystem health and living resources.

In contrast to the significant progress achieved in the design and implementation of the basin-scale, ocean-climate module of GOOS, less has been achieved in the development of the coastal module. According to Malone (2001), this is due largely to:

- Difficulties in designing and implementing an internationally accepted system able to provide the required information for detection and prediction of changes in diversity and complex coastal ecosystems;
- Inefficient data management systems that are unable to capture significant amounts of relevant data and hinder rapid collation of diverse data from disparate sources;
- Insufficient capacity for detection and prediction of changes in phenomena requiring measurements of biological and chemical variables;
- Lack of mechanisms (institutional and fiscal) for the selective transition of research activities and products into an operational framework based on user needs; and
- The challenges of developing the regional and global partnerships, particularly in developing countries, needed to fund the implementation of the coastal module.

3.3 Selected examples of environmental indicators at the regional level

At the regional level, the European Union seems to lead the way in the development and monitoring of environmental indicators, with its EC/EUROSTAT Environmental Pressure Indicators program and its various initiatives and agreements. An additional regional effort in the Mediterranean is discussed in this section.

European Union

The Kiev Guidelines

In preparation for the environmental ministerial conference in Kiev in 2003, the European Environment Agency (EEA) is preparing a series of guidelines for a pan-European indicator-based assessment of the state of the environment. To this end, the EEA has prepared a report that outlines the content of the future guidelines (Wright and Russel 2001).

The report includes information on coastal and marine issues such as socioeconomic sectors (fisheries and mariculture), water, biological and landscape diversity, and progress in managing environment and sustainable development.

Coastal zone management in particular, is considered in the framework of successful/unsuccessful planning tools. Coastal zone management will be taken as an example for problem solving in specific areas with conflicting interests and high environmental values. In this perspective, a comparative assessment of coastal zones on a regional basis will be provided. This assessment will compare the major pressures on coastal ecosystems and areas where carrying capacity to sustain economic activities have reached their limits. The development of integrated coastal zone management (ICZM) will be assessed in terms of its contribution to physical planning, institutional integration, and other tools.

State and progress will be assessed through an indicator—still to be defined—able to describe in qualitative terms the pressures on coastal zones and the progress in Integrated coastal zone management (ICZM).

In terms of data retrieval, the information will be available at the European Topic Centre on Marine and Coastal Environment (ETC/MC), which has produced a report including data that reflect progress in ICZM in 14 European countries (181 regions). Intermediate date on ICZM progress will be available in 2003 (see below for the ETC/MC).

EEA ETC/MC

At the ETC/MC level, the use of "ecological" and "headline" indicators for the marine environment was discussed between 1998 and 2000 in a series of workshops. An initial set of 80 physical, chemical and biological parameters suitable for the further development of the system of indicators was developed, contributing to the establishment of 30 indicators. Based on the DPSIR system a sample of indicators was first developed in 1998 for eutrophication, chemical pollution, and fisheries (Peronaci 1999), (see Table 3-7 for eutrophication indicators).

In 1999, the indicators for eutrophication were tested according to the following methodology: (1) checking of data availability of descriptive parameters; and (2) testing of adequate time series and spatial coverage. The testing led to the development of trends of phosphate concentrations and loads in European seas (Peronaci 2000) and to the implementation of the Marinebase eutrophication and harmful substances database (Nygaard, Rygg et al. 2001).

Table 3-7 *Initial set of coastal eutrophications indicators at the European level*

Issue	Pressure	Impact	State	Response
Eutrophication	The load of total nitrogen in tons per year	The algal blooms expressed as (frequency * extent) in km2/yr	The total concentration of nitrogen for its diverse forms in mg/l	Environmental: the rate of restoration in percentage of the base level of total dissolved oxygen
	The load of orthophosphates in tons per year		The total concentration of orthophosphates in mg/l	
			The total concentration of dissolved oxygen in mg/l	Policy: the rate of progress in nutrient discharge control measures

Source: ETC/MC

The ETC/MC ceased to operate in 1999. Its activities on indicators are being continued by two other ETCs. The European Topic Center on Water (ETC/WTR) is developing a core set of indicators for all types of water body, in order to produce an indicator-based report on water. The European Topic Centre on Territorial Environment (ETC/TE) is developing indicators under different thematic areas, namely, soil, land use and coastal zones. The products of both the ETCs are still under development, precluding a review of the indicators for water and the terrestrial environment or an assessment of their level of integration.

The Sustainability Targets and Reference Program

The STAR program (Sustainability Targets And Reference values) provides an inventory of environmental targets and sustainability reference values (SRVs) applicable in the European Union (EU), in countries in the European Free Trade Association (EFTA), in Central and Eastern Europe (CEE), and in the Newly Independent States (NIS). The STAR database, available on line at the web site of the European Environment Agency (EEA),[1] is currently under development and focuses particularly on standards and targets reflected in EU legislation, international law, and international scientific and technical bodies. The database also contains information on national targets and standards.

STAR is organized around environmental issues, economic sectors, regions and areas, and actions for improving the environment. Information on targets and standards on coastal and marine issues can be found within different components. The "coastal and seas" component contains over 2000 targets and standards, organized into binding and non-binding instruments: laws, opinions, guidelines, policies, conventions, resolutions, standards, recommendations, policy targets, directives, decisions, protocols, voluntary agreements, initiatives, and regulations.

[1] *http://star.eea.eu.int/default.asp*

Targets and standards collected in the STAR database provide an interesting inventory of environmental performance indicators. A breakdown of targets and standards can be organized by binding and non-binding instruments and according to the country.

At the level of the European Union (EU15), for example, 356 targets and standards can be identified directly or indirectly related to coasts and seas. These targets, in turn, refer to different types of instruments adopted by the EU and its Member States, such as directives, regulations, and action plans on, for example, the quality of bathing waters, the quality of shellfish waters, urban wastewater treatment, fisheries, or protection of biodiversity.

The Report on Environmental Measures (REM)

These reference targets are of interest to the extent their incorporation into national policy measures and their effects and effectiveness can be measured. A recent report by the EEA (Vaz, Jock et al. 2001) sheds light on the crucial issue of the effects of EU environmental legislation and whether specific measures have actually been effective in delivering expected results. The report aims to contribute to the development of a more effective and streamlined future regime for reporting on environmental measures.

For more detail, the report uses case studies to (1) assess the extent to which policy measures can be linked to their impacts on the environment, (2) review the scope and contents of reporting requirements in EU environmental legislation, (3) develop reporting and effectiveness evaluation methodologies, and (4) identify options for a new EU reporting regime coordinated with international reporting obligations.

The report provides justification for assessing the effect and effectiveness of environmental measures. These justifications, based on the conclusions of the global assessment of the 5th

EU Environmental Action Programme, that call for *ex ante* evaluation of environmental impacts of new policies and ex post evaluation of the effectiveness of existing measures in meeting their environmental obligations, include:

- Scenario development;
- Distance to target analysis;
- Comparison of the cost-effectiveness of policy measures; and
- Shared policy-learning.

In synthesis, the report concludes that:

- More information is needed on the effects and effectiveness of EU measures;
- The current reporting system is not equipped to deliver information on the effects and effectiveness of EU measures (the Directive on environmental reporting addresses only some of the shortcomings and there is not enough guidance on reporting by the EU itself);
- Evaluation needs should be built into the design of policy and legislation since the beginning, evaluation requiring the same information requested by environmental reporting (e.g., in the case of Structural Funds); and
- The most appropriate mechanism to assess effects and effectiveness must be found: reporting should not necessary be channeled through the legal system and a cost-effective way of reporting, disseminating, and sharing results would be to use an Internet site accessible to all.

EC/Eurostat Environmental Pressure Indicators for EU: Indicator Definition

The EUROSTAT project aims to create a set of pressure indicators, describing pressures resulting from human activities, thereby building a bridge between environmental science and decision-making. It is divided into 10 policy fields: air pollution and acidification; climate change; loss of biodiversity; marine environment and coastal zones; ozone layer depletion; resource depletion; dispersion of toxic substances; urban environmental problems; waste; and water pollution and water resources.

This project uses the PSR framework found within the OECD, World Bank and World Resources Institute projects. Each policy field has six core pressure indicators selected by experts in that field and analyzed in terms of policy relevance, analytical soundness, and responsiveness (response elasticity). Core indicators are comprised of three different types of indicators (simple, combined, and relative), with a clear preference within this project for combined indicators. These are best expressed within the context of effect-related equivalents.

In the Marine Environment and Coastal Zones field, there are four main pressure categories: pollution, unsustainable use, infrastructure development, and biodiversity and natural habitats. Table 3-8 reveals how the core indicators for this policy field often overlap in the main pressure categories. The indicator definitions and measurement units for these ten core indicators are shown in Table 3-9.

This policy field is extremely broad and in order to avoid potential overlap with other policy fields "Marine Environment and Coastal Zones" was arbitrarily bound with the following constraints:

- Issues related to biodiversity in the marine and coastal environment are dealt with under this policy field and not under Loss of Biodiversity; and
- All issues associated with freshwater are dealt with under Water Pollution and Water Resources.

Table 3-8 *Marine environment and coastal zones: core indicators from EUROSTAT*

Pressure category	Core indicator
Pollution	Eutrophication
	Discharges of heavy metals
	Oil pollution at coast and at sea
	Discharges of halogenated organic compounds
	Tourism intensity
	Faecal pollution
Unsustainable use	Overfishing
	Tourism intensity
(Infra)structure development	Development along shore
	Tourism intensity
Biodiversity and natural habitats	Priority habitat loss
	Wetland loss

Source: TEPI

Table 3-9 *Core Indicators for the policy field Marine Environment and Coastal Zone from EUROSTAT*

Indicator	Indicator definition	Measurement unit
Eutrophication	Nutrient enrichment of water bodies, primarily by nitrogen (N) and phosphorus (P)	The input of total nitrogen and total phosphate, in tons N and tons P
Overfishing	Total catch of quota and non quota fish, shellfish and crustacean species	Tons
Development along shore	Increase in structural development in the coastal zone	Real (ha) or percentage (%) increase in structural hard surfaces
Priority habitat loss	Net decrease in priority habitats	Ha
Discharges of heavy metals	Volume of heavy metals entering the coastal zone and marine environment from all sources	Tons
Oil pollution at coasts and at sea	Total accidental, licensed and illegal disposal of mineral oil to the coastal and marine environment	Tons
Discharges of halogenated organic compounds	Volume of halogenated organic compounds entering the coastal zone and marine environment from all sources	Tons
Wetland loss	Loss of size and function of coastal wetlands (e.g., fens, marshes, peat lands, intertidal areas or shallow water)	Ha. Loss of function may be measured as the sum of individual pressures such as pollutant loads and overexploitation
Tourism intensity	Increase in tourism intensity	The increase in number of tourists per square kilometer of coastal zone
Faecal pollution	Discharge and dumping of faecal material into coastal areas	Tons equivalent (or tons equivalent per chosen critical time period when looking at the human health aspect)

Source: TEPI

Within the process of review of pan-European indicators, the European Topic Centres (ETCs) led by the EEA have developed a core set of 400 indicators applicable to the following areas:

1. Agriculture
2. Air pollution
3. Biodiversity
4. Climate change
5. Energy
6. Fishery
7. Ozone depletion
8. Terrestrial environment
9. Tourism
10. Transport
11. Water
12. Waste and material flows

Many of these indicators have a direct relevance to ICM, as shown in Table 3-10 of the following page.

Table 3-10 *Core EEA indicators referred to coastal and marine issues*

Sector or media	Code	Indicator	Type
Energy	EE16	Oil spills	Environmental
	EE17	Oil discharges	Environmental
Fishery	FISH1	Status of marine fish stocks	Environmental
	FISH2	Metrics of community structure	Environmental
	FISH3	Fish stock characteristics	Environmental
	FISH4	Spawning stock biomass	Environmental
	FISH5	Aquaculture Production per coastal area	Socioeconomic
	FISH6	Physical damage to habitats and species	Environmental
	FISH7	Discards	Socioeconomic
	FISH8	By-catch	Socioeconomic
	FISH9	Production of non indigenous species new: Indicator on introduction of alien species by mode of introduction (aquaculture) from water core set	Socioeconomic
	FISH10	Quality of effluent water	Environmental
	FISH11	Biodiversity indicators near farms compared with away from farms	Environmental
	FISH12	Quality of fish for human consumption (Fisheries & Aquaculture)	Environmental
	FISH13	Gear loss	Socioeconomic
	FISH14	Fishing mortality	Environmental
	FISH15	Fishing capacity of fleets (new title)	Socioeconomic
	FISH16	Fishing effort	Socioeconomic
	FISH17	Maximum sustainable yield/fishing effort	Socioeconomic
	FISH18	Catch per Unit Effort	Socioeconomic
	FISH18B	Ecoefficiency of aquaculture	Governance
	FISH19	Fish consumption per capita	Socioeconomic
	FISH20	Catches by major species and areas	Socioeconomic
	FISH21	Average wage (Fisheries & Aquaculture)/average national wage	Socioeconomic
	FISH22	Market demand (F & A) or Price - First sale value/cost	Pressure
	FISH23	Fisheries restructuring	Governance
	FISH24	Quota management	Governance
	FISH25	Zone management	Governance
	FISH26	Percentage of fisheries reflecting environmental integration	Governance
	FISH27	Percentage of aquaculture complying to Fish Farms Code of Conduct	Governance
Terrestrial environment	TE004	Accidental and illegal discharge of oil by ships to the sea	Environmental
	TE034	Coastal erosion and progradation trends	Environmental
	TE077	Impact of coastal erosion on real estates	Socioeconomic
	TE080	Impacts of land use on coastal ecosystems	Environmental
	TE111	Seasonal population in the coastal zone	Socioeconomic
	TE116	Progress in coastal management / ICZM	Governance
	TE119	Protection of coast against erosion	Governance
	TE128	Sea level rise index by coastal unit	Environmental
Tourism	TOUR7	Construction of coastal defence	Governance
	TOUR8	Bathing water quality	State
	TOUR17	Construction of second homes on coastal zones	Socioeconomic
	TOUR19B	Frequentation in coastal and mountains zones	Socioeconomic
	TOUR40	Tourist tax revenues and public expenditure for tourism development and conservation	Socioeconomic
Transport	TERM10	Accidental and illegal discharges of oil at sea	Environmental
Water	WEU7	Nutrients in coastal waters	Environmental
	WEU8	Atmospheric deposition of nitrogen to marine and coastal waters	Environmental
	WEU18	Chlorophyll in transitional, coastal and marine waters	Environmental

Sector or media	Code	Indicator	Type
Water	WEU19	Phytoplankton in transitional and coastal waters	Environmental
	WEU20	(D) Frequency of low bottom oxygen in deep layers of marine waters	Environmental
	WEU21	Urban waste water treatment	Governance
	WEU22	Implementation of Nitrate Directive	Governance
	WHS5	(D) Hazardous substances in transitional, coastal and marine waters	Environmental
	WHS6	(D) Hazardous substances in marine sediment	Environmental
	WHS7	Hazardous substances in marine organisms	Environmental
	WHS8	Loads of hazardous substances to coastal waters	Environmental
	WHS9	Atmospheric deposition waters of heavy metals and persistent organic pollutants (POPs) to marine and coastal waters	Environmental
	WHS15	Discharge of oil from refineries and offshore installations	Environmental
	WHS16	Accidental oil spills from marine shipping	Environmental
	WHS17	Illegal discharges of oil at sea	Environmental
	WHS19	(M) Biological effects of hazardous substances on marine organisms	Environmental
	WHS20	(D) Oiled seabirds	Environmental
	WEC1	Benthic invertebrate fauna in transitional and coastal waters	Environmental
	WEC3	Habitats in transitional, coastal and marine waters	Environmental
	WEC4	Classification of transitional and coastal waters	Governance?
	WEC7	Introduced species in marine and coastal waters	Environmental
	WEC9	Implementation of EU Water Policies	Governance
	WEC10	Integrated Coastal Zone Management	Governance

Source: http://eea.eu.int

Numerous other indicators, although of a general nature rather than specifically coastal or marine - e.g., fragmentation of ecosystems and habitats, erosion of biodiversity resulting from visitor's frequentation in protected areas, or redevelopment of brownfields for new urban uses - could be used for ICM. In this draft list, some indicators are repeated for different areas, as in the case of illegal oil discharges at sea for the terrestrial environment, transport, and water and ICM for both the terrestrial environment and water. More detailed information is available on some key indicators on sustainable fisheries. Such indicators are described in Table 3-11.

Table 3-11 *Fishery indicators in the EEA*

Indicator	Description	Policy issue
Fish stocks outside safe biological limits	The ratio of the number of overfished stocks (stocks outside safe biological limits) to the number of commercial stocks (for which assessment of their status has been carried out) per fishing area	EU policies and in particular the common fisheries policy (CFP), aim for sustainable fishing over a long period of time through appropriate management of fisheries within a healthy ecosystem, while offering stable economic and social conditions for all those involved in the fishing activity
The North Sea cod (Gadus morhua) stock	Recruitment and spawning stock biomass in relation to the biomass precautionary approach reference point	Sustainable exploitation of fish stocks is a target for the EU-CFP. Landings are regulated through TAC, but this does not directly lead to control of the actual catches
Fishing fleet trends	Fishing fleet in terms of number, tonnage and power	EU policies aim through appropriate management of fisheries for sustainable fishing, over a long period of time within a sound ecosystem, while offering stable economic and social conditions for all those involved in the fishing activity
Trends in aquaculture	Fish and shellfish acquaculture production in coastal and inland waters	There are no general policy targets for aquaculture, though the assessment of the environmental impact of specific installations and fish farms would have to be undertaken under EC legislation (Environmental Impact Assessment Directive 85/337/EEC)

Source: http://eea.eu.int

The utility of these indicators is based in their reduced number and simplicity. While the indicator on the conditions of fish stocks and fleet trends can link state and pressures (also through the use of the indicator on the North Sea cod as a key fish stock) the indicator on trends in aquaculture signals an area in strong expansion where policy targets will have to be defined.

Box 3-2 Key findings on the EU

- A system of indicators for coastal zone management is being developed at the European level by the EEA and its associated bodies such as the ETC/MC.
- The system of indicators is based on the DPISR framework, emphasizing the dynamics of environmental change and the impacts of human activities.
- The coastal indicators appear well established for measuring in quantitative terms issues of eutrophication, harmful substances, and fisheries, also in connection with the reporting obligations of various regional marine conventions.
- Indicators for measuring progress in ICZM, on the other hand, are still underdeveloped and rely on an overall self-assessment by coastal managers, with no quantified evaluation of specific aspects of ICZM performance.
- Environmental performance indicators are still insufficiently developed but getting increased attention in Europe, in the prospect of renewing the reporting regime established under European environmental law.
- In preparation of the Kiev ministerial meeting in 2003, the EEA is developing guidelines for a pan-European indicator-based assessment of the state of the environment, including ICZM. At the moment, however, the work is still in progress.

The Mediterranean Action Plan

Environmental indicators

The Blue Plan Regional Activity Centre (BP/RAC) of the Mediterranean Action Plan (MAP), the firstly-established regional seas action plan by the United Nations Environment Programme (UNEP) has done substantive work to develop indicators of environmental performance in the Mediterranean region (Blue Plan and METAP 1998a).

The environmental performance indicators, measuring the gap between environmental targets and their achievement, have been developed between 1996 and 1999 by Blue Plan with the support of the Mediterranean Technical Assistance Programme (METAP) in 13 Mediterranean countries: Albania, Algeria, Croatia, Cyprus, Egypt, Jordan, Lebanon, Morocco, The Palestinian Territories, Slovenia, Tunisia, and Turkey (Blue Plan and METAP 1998b).

During a series of regional and subregional workshops a series of four priority issues were identified: (1) air pollution, (2) solid waste, (3) quantitative management of solid waste, and (4) water pollution. Three tests were implemented in 1999–2000 to assess the availability of the indicators and test their reliance: in the Palestinian Territories, Turkey and Egypt.

Indicators for Sustainable Development

Following the recommendations of the Contracting Parties to the Barcelona Convention (20 Mediterranean-rim nations and the European Community) at their meeting in Malta in October 1999, the Blue Plan assisted Mediterranean countries in developing indicators for sustainable development (Box 3-3). Based on an initial list of 250 indicators, 140 of which derived from the United Nations Commission on Sustainable Development, a set of 130 indicators was selected through two workshops held in Tunis (June 1998) and in Sophia-Antipolis (May 1999). The indicators were validated by national tests held in Slovenia and Tunisia, the latter in collaboration with the French Institute for the Environment (IFEN). The set of 130 indicators are discussed in a methodology document (UNEP, MCSD et al. 2001) and accompanied by a glossary (Blue Plan 2000).

The selection of the 134 indicators—organized according to the Pressure-State-Response (PSR) model—was done in 1995 and 1996. Each indicator was accompanied by the methodological sheets provided by the 1996 UN "Blue Book." The technical tests developed in 22 countries in different forms, including shared experience and twinning, and the results of the workshop highlighted a series of observations on the indicators.

The indicators most relevant to the coastal areas—intended as the interface between the land and the sea—pertain to the following categories:

- Population and planning, society and human development;
- Economy and activities; and
- Environment and natural resources.

The inclusion of population growth and population density under state indicators rather than pressure indicators is debatable. Most indicators can be used at both the national and subnational level, including a 100-m coastal strip.

The indicators were tested in Slovenia: in 1999, in a 3-month exercise on the national level, and, in 2000, in a 1-month exercise focusing on the coastal area, including three towns representing 1.7 percent of the territory and eight percent of the population. It included 55 indicators, four of which were considered not pertinent and two more pertinent in small urban areas.

The BP/RAC has collaborated with the Priority Actions Programme Regional Activity Centre (PAP/RAC) of the Mediterranean Action Plan (MAP) in the development of indicators for prospective analysis of system sustainability. In particular, this approach has been adopted in three projects:

- Iskenderun Bay (Turkey);
- Sfax Coastal Area Management Programme (CAMP) (Tunisia); and
- Malta CAMP

In the context of these programs, indicators were also used to forecast evolutions into the future and not just for a retrospective view.

Box 3-3 Key findings on the Mediterranean

- In the Mediterranean, the Blue Plan has developed, in collaboration with the EEA, METAP, and the MCSD, indicators for environmental performance and sustainable development that represent an important regional adaptation and application of the work already developed by the UN, OECD, and the EEA.
- This activity has led to the selection of a core set of 16 indicators for sustainable development of coastal and marine areas flexible enough to be used at different geographical scales: marine areas, national level, coastal regions, coastal strip (100 m), and Mediterranean spots.
- The work of the Blue Plan is oriented towards the development of environment-development scenarios and in this context its collaboration with PAP/RAC has resulted in the development of methods and tools for systemic analysis in some CAMPs (Iskenderun Bay, Sfax, and Malta).

3.4 Selected examples of environmental indicators at the national level

The following discussion examines the national initiatives for environmental indicators from the following countries: Canada, the United States, France, the United Kingdom, Sweden, Australia, and New Zealand.

Australia

To meet its international obligations under Agenda 21 and the OECD environmental performance reviews, Australia initiated a *National Strategy for Ecologically Sustainable Development*, supported by the Commonwealth State of the Environment Reporting system. In September 1996, the Commonwealth Environmental Minister released the first comprehensive and independent assessment of this country's environment: *Australia: State of the Environment 1996.* This report cited Australia's lack of "the data, the analytical tools or the scientific understanding" needed to determine whether it was on a sustainable track.

Australia's 1998 *State of the Environment Environmental Indicator Report* discussed the next step necessary for improved reporting of the system: the development of a national set of indicators that would facilitate the tracking of environmental conditions and the anthropogenic forces on them. Of the seven major themes upon which this 1998 environmental report was based, that of "Estuaries

and the Sea" encompassed 61 ocean and coastal management indicators for use at the national level.

The 61 ocean and coastal indicators may be classified as such:

- 3 pertaining to species or taxa;
- 9 to habitat extent;
- 17 to habitat quality;
- 6 to renewable products;
- 2 to non-renewable resources;
- 5 to sediment or water quality;
- 17 to integrated management; and
- 2 to ecosystem-level processes.

The majority of the indicators, therefore, measure environmental changes, while 17 measure integrated governmental and/or socioeconomic factors (to be discussed in Chapters 6 and 5, respectively).

The selection of the 61 indicators involved much scrutiny. Australia recognized the need to promote integrated coastal and ocean management by working toward a more ecosystem-management approach when selecting indicators. In order to adequately report on the true condition of an ecosystem and to better meet the goals of integrated management, five core attributes were established to direct the development of environmental indicators: stability, diversity, yields, resilience, and productivity. Each of the indicators selected pertained to one or more of these attributes as well as to the OECD PSR model. Furthermore, the indicators were selected according to the following criteria (selected from an extensive list): scientific credibility, cost-effectiveness, measurability, national scope, and ability to provide an early warning of future problems.

Australia chose both structural and functional environmental indicators. However, the overall indicator set consisted of more structural indicators, due to their tendency to be more sensitive and thus, provide earlier notice of significant environmental change. Australia also emphasized the importance of choosing the appropriate spatial and temporal parameters within which to measure each indicator. These proper measurement scales as well as the inclusion of uncertainty estimates in the reported data are considered crucial for accurate and credible State of the Environment (SoE) reporting. Also, in order for the data collected at the local level to be considered relevant for reporting at the international level, Australia deemed it necessary to compile data summaries at each level of government. For example, after collecting the data at the local level, it could be reported to the state and territory governments, which would synthesize it and report the findings to the Commonwealth, which could further delineate national trends and summarize the findings for reporting internationally.

Table 3-12 outlining Australia's environmental indicators, does not include Class 7 indicators which will be discussed in Chapter 5 on Governance indicators.

The complete set of Australian indicators is noted as a good example of a formal reporting system that uses tiers of indicators to create a national snapshot of conditions. These indicators, found at all levels of government, are more detailed at the local level and eventually feed into the international level after summarization and synthesis.

Unfortunately, significant gaps in knowledge were noted at a range of levels, including: distributional data on species and assemblages and a lack of available statistical tools relevant to SoE uses, qualified taxonomists, and one synthesis of existing biological data and information.

Table 3-12 *Australia's environmental indicators*

Element or issue	Indicator	Type of indicators: S= Socioeconomic G= Governmental E= Environmental	C= Condition P= Pressure R= Response
	Class 1: Cited taxa/species		
Protected Species	Rare, endangered or threatened marine species	E	R
Cited species/taxa	Protected species populations	E	C
Cited species/taxa	Seabird populations	E	C
	Class 2: Habitat Extent		
Habitat Extent	Algal bed area	E	C
Habitat Extent	Beach and dune area	E	C
Habitat Extent	Coral reef area	E	C
Habitat Extent	Dune vegetation	E	C
Habitat Extent	Intertidal reef area	E	C
Habitat Extent	Intertidal sand/mudflat area	E	C
Habitat Extent	Mangrove area	E	C
Habitat Extent	Saltmarsh area	E	C
Habitat Extent	Seagrass area	E	C
	Class 3: Habitat Quality		
Habitat Quality	Algal bed species	E	C
Habitat Quality	Algal blooms	E	P
Habitat Quality	Beach species	E	C
Habitat Quality	Coral reef species	E	C
Habitat Quality	Dune species	E	C
Habitat Quality	Fish populations	E	C
Habitat Quality	Intertidal reefs species	E	C
Habitat Quality	Intertidal sand/mudflat species	E	C
Habitat Quality	Islands and cays species	E	C
Habitat Quality	Mangrove species	E	C
Pests (exotic)	Pest numbers	E	P
Habitat Quality	Saltmarsh species	E	C
Habitat Quality	Seamount species	E	C
Habitat Quality	Seagrass species	E	C
Pests (native)	Species outbreaks	E	P
Habitat Quality	Subtidal sand/mudflat species	E	C
Habitat Quality	Chlorophyll concentrations	E	C
	Class 4: Renewable Products		
Aquaculture	Aquaculture effort	S	P
Aquaculture	Aquaculture production	S	C
Seafood	Fish stocks	S	C
Seafood quality	Seafood quality (contamination)	E	C
Effects of fishing	Trawl fishing area	S	P
Effects of fishing	Fishing gear	S	P
	Class 5: Non-renewable Products		
Mining	Ocean exploration	S	P
Mining	Ocean mining	S	P
	Class 6: Water/Sediment Quality		
Sediment quality	Sediment quality (contaminants)	E	P
Water quality	Sentinel accumulator program	E	P
Water quality	Turbidity	E	P
Water quality	Water nutrients (nitrogen)	E	P
Water quality	Seabird eggs (contamination)	E	P
	Class 8: Ecosystem-level Processes		
Ecosystem process	Sea level	E	C
Ecosystem process	Sea surface temperature variability	E	C

Source: State of the Environment Report, Estuaries and the Seas

Canada

From 1988-1999, Environment Canada's State of the Environment Directorate (subsequently changed to the Indicators and Assessment Office) began developing a preliminary set of environmental indicators. The National Marine Indicators Working Group is tasked with developing a national set of marine indicators based on two primary focus areas: sustainable use and marine environmental quality. In April 1991, a preliminary set of 43 indicators in 18 topical areas was presented; since then this set has been built upon by the Indicators and Assessment Office (Vandermeulen 1998).

For the first primary focus, sustainable use, indicator listings and descriptions have been published for stocks of specific species and groupings, including Pacific Herring, Atlantic invertebrates, and Pacific Salmon. Publications have included not only the environmental aspects of the fisheries but also socioeconomic aspects such as value of total landed catch and number of employees for harvesting and processing. In this category indicators relevant to ocean and coastal management are few.

For the second primary focus, marine environmental quality, five subcategories have been assigned:

- Contaminants;
- Biotoxins, disease and pathogens;
- Species diversity and range of size;
- Nutrients and primary productivity; and
- Instability.

Marine Environmental Quality

Canada undertook an inventory and review of marine environmental quality (MEQ) programs for the inshore, coastlines and seas of North America (Canada, USA, and Mexico), Europe (in particular the UK and Baltic), Australasia (Australia and New Zealand), and other applicable regions (EcoHealth Consulting 2001). Drawing from these worldwide experiences, Canada is better equipped to structure its own MEQ monitoring program.

Six topic areas were examined:

1. Contaminants (metals and synthetic molecules);
2. Species diversity and size spectrum (trophic structure, pelagic and benthic communities, habitat changes, fisheries impacts);
3. Primary productivity and nutrients (eutrophication);
4. Pathogens, biotoxins, and disease agents (including parasites, faecal coliforms and algal toxins);
5. Instability ("regime shifts" or multiple stable staes in community structure related to large-scale changes in oceanographic conditions such as El Niño); and
6. Physical parameters (sedimentation, pH, erosion, oxygen depletion, etc.).

In conducting this international comparison, indicators within each of the eight categories were compared across the countries and regions, and evaluated according to relevance, clarity of interpretation, and relevance to ecosystem health. Accordingly, MEQ indicators were ranked as either "excellent," "good," "fair," or "poor." Some of the indicators, ranked highest by Canada, include:

- Measures of nutrients and primary productivity (primary biomass and water column nutrients) = Excellent;
- Measures of instability (shifts in salinity and temperature) = Excellent;
- Measures of physical parameters (N and P concentration) = Excellent;
- Species diversity/size range (fish community composition) = Good; etc.

The complete list of indicators is given in Table 3-13. The rating criterai are:

- Excellent = Outstanding;
- Good = Highly desirable but with some limitations;
- Fair = Worthy of consideration, but many limitations; and
- Poor = Disadvantages outweigh advantages.

Table 3-13 *Feasibility and utility of indicators for marine environmental quality (MEQ)*

Types of pollutants	In general	For Canada
A. Contaminants (metals and synthetic organic molecules)		
Heavy Metals and POPs in Sediments	Good	Good
Heavy Metals in biota (fish tissue)	Good	Good
Organometallic compounds, (e.g., TBT)	Good	Limited use
Priority organochlorines in tissues of fish/shellfish, fatty tissues of predators (e.g., seabirds, porpoises, seals and otters)	Good	Good

Types of pollutants	In general	For Canada
Polychlorinated Biphenyls (PCBs)	Good	Good
Dioxins	Good	Good
Endocrine Disrupters	Fair	Poor
Radionuclides in water	Good	Poor
B. Species Diversity/Size Spectrum and Community Composition		
Composition of fish communities	Good	Good
Invertebrate benthic communities	Good	Fair
Phytoplankton communities	Good	Good
Exotic marine species in ballast	Good	Good
Size spectrum	Fair	Fair
C. Primary Productivity and Nutrients		
Chlorophyll a	Excellent	Excellent
Primary Biomass	Excellent	Excellent
Export photosynthetic carbon (gC/m2)	Excellent	Excellent
Nutrients in water column	Excellent	Excellent
Sedimentation	Good	Good
D. Pathogens, biotoxins and disease		
Natural Toxins from phytoplankton (e.g., PSP, domoic acid, affecting the edibility of molluscan and crustacean shellfish)	Good	Good
Human and animal pathogens (e.g., Pfiesteria, E. coli)	Good	Good
E. Biomarkers		
Bio-accumulation in populations of colonial water-birds, especially pelagic seabirds	Good	Good
Contaminants in blue mussels	Good	Good
Reproductive disorders (e.g., imposex in marine snails from harbors, exposed to organotins; female characteristics in male fish near pulp mills where fish exposed to chlorinated organics)	Fair	Fair
Diseases in benthic fish species, (e.g., tumor/neoplasms in flatfish)	Good	Good
Toxicity of harbor and coastal sediments to benthos	Good	Good
F. Instability (regime shifts)		
Shifts in fish communities	Good	Good
Sea temperature/salinity shifts	Excellent	Excellent
Sea color (representing phytoplankton responses to changes in nutrient availability)	Excellent	Excellent
G. Physical parameters		
Acidity (pH)	Excellent	Excellent
Oxygen depletion in bays/Harbors (BOD)	Excellent	Excellent
Nutrient concentrations (nitrogen and phosphorus)	Excellent	Excellent
Turbidity in bays/harbors/ Coastal areas/semi-enclosed seas	Excellent	Excellent
H. (New) Habitat conditions		
Mapping of habitat quality	Fair	Good
Area of preservation of marine habitat	Excellent	Excellent

Lack of broad-based monitoring programs continues to inhibit the development of MEQ indicators in the categories of nutrients and primary productivity and parasites and biotoxins. Like many countries, Canada's indicator sets for marine environmental quality are incomplete or pending. Its approach to MEQ indicators has often been fragmented by its tendency to view fisheries apart from other ocean uses.

France

In 1996, France applied as one of 22 countries to test the 134 sustainable development indicators designed by the Commission on Sustainable Development described earlier in this chapter (using the PSR model). In the environmental category, France identified 16 driving force indicators, 17 state indicators and 11 response indicators.

This effort has proven strong in that it has resulted in a detailed review of definitions, methodologies, sources and data for UN-listed indicators. Unfortunately, the country did not select a preliminary national set of indicators due to the contradictory goals of achieving national relevanceand international comparability. A preliminary "national selection" of indicators was not completed. The French Institute for the Environment (IFEN) is currently working toward a national list of sustainable development indicators, using an original approach, which integrates different areas of sustainable development. It has tested this framework, on a limited basis, to determine whether or not it is flexible enough to develop indicators that can be applied broadly and across a range of perspectives.

France's experience with the CSD framework led to the conclusions that any near-future possibilities for aggregating indicators is virtually impossible. Many of the indicators were difficult to interpret, which led to the suggestion of breaking down certain indicators according to specific activities, sectors, or geographical regions/areas.

Table 3-14 *New Zealand's Environmental Performance Indicators*

Indicator topic area	Indicator
Chemical/Physical	Marine spills
	Sedimentation risk and land use
	Sedimentation
	Eutrophication risk and land use
	Eurtrophication
	Chlorophyll-a or trophic index
	Toxic contaminants
Communities and Habitat	Marine habitat extent
	Percent area protected
Human Values and Health	Quality of beach water
	Litter
	Area of land owned by the public
	Time closures of shellfishing and swimming areas
	Algal blooms
	Natural character
	Public access areas
Species	Threatened taxa
	Alien species
Fish Stocks	Fish stocks
Fishing Impacts	Fishing impacts

New Zealand

Under the auspice of the Environmental Performance Indicators Programme the Ministry of Environment is currently developing environmental indicators for New Zealand. Table 3-14 provides an overview of current indicators.

It is too early in New Zealand's program history to analyze its strengths and weaknesses.

South Africa

In accordance with the objectives of Agenda 21, South Africa's National Coastal Management Policy seeks to achieve integrated coastal management and sustainable resource use. Its ocean and coastal environmental indicators are grouped under the "Sustainability of Coastal and Marine Ecosystems" category in the State of the Environment Reports. Five indicators are detailed under this category.

Table 3-15 *Indicators in South Africa's National Coastal Management Policy*

Indicator	Definition
Ship traffic round the Cape	This indicator provides detailed information on the numbers of vessels, the direction traveled (east or west) and the time period (month and year) in which the travel occurred. The type of vessel transport (e.g., cargo, and research vessel) is also described.
Number and status of estuaries	This indicator ranks South Africa's estuaries according to size (large, small, large and small, or combined), number, and the present condition resulting from human usage (good, fair, poor, unscored).
Sea level rise	This indicator measures the changes in sea level rise (in millimeters) at four different recording stations.
Stocks of marine resources	This indicator gives detailed information on the number of tons caught of different types of fish (e.g., Anchovy, Sole), the place where caught (East, West, or South coast), and the years when caught.
Number of marine protected areas	This indicator gives the number of MPAs in four different regions, as well as the function of the MPA (e.g., preservation, tourism, fishing, or education).

One of the strengths of South Africa's initiatives is that its environmental indicators have been incorporated into the DPSIR model. Additionally, its National State of the Environment Report shows indicator linkages by sector (e.g., terrestrial and coastal ecosystems), thereby painting a more comprehensive picture of the sectoral interactions. Environmental indicators for marine and coastal systems are in need of further development.

Sweden

The Swedish government is currently proposing a new results-based management framework for elaborating and implementing its environmental goals. The Swedish Environmental Protection Agency has submitted proposals for new goals; out of the 15 goals on national environmental quality, five apply to the coastal and marine ecosystems. The coastal and marine ecosystems goals include: flourishing wetlands; sustainable archipelagoes and coastal areas; no eutrophication; a non-toxic environment; and limited influence on climate change.

More of an effort is needed to monitor the environmental performance of managing institutions. Sweden does not have a national set of ocean and coastal indicators that conform to the corresponding objectives in its five proposed areas of concern. Developing these goals will be extremely important in order for Sweden to meet its objectives by 2020-2025.

United Kingdom

At the national level, the United Kingdom has had two federal agencies prepare sets of environmental indicators. The Environment Agency has produced state of the environment indicators that include oceans and coasts. The Department of the Environment, Transport and the Regions (DETR) has produced two lists of sustainable development indicators. Table 3-16 details the latest list of indicators.

With different national agencies creating sets of indicators for use, the United Kingdom appears to have a fragmented approach regarding the environments of the ocean and coasts. This is a major stumbling block and reflects an imbalance between environmental indicators and indicators measuring socioeconomic and governmental indicators.

Table 3-16 *Objectives and Indicators from "Quality of Life Counts", United Kingdom*

Objective	Indicator
Reduce or eliminate inputs of hazardous and radioactive substances of most concern	Estuarine water quality, marine inputs
Aim to raise consistent compliance with the European Bathing Water Directive	Compliance with Bathing Water Directive
Protection of marine habitats and species	Biodiversity in coastal/marine areas
Improve the management and conservation of fish stocks	Fish stocks around the UK fished within safe limits
Work with other countries to achieve effective management and conservation of fish stocks	State of the world's fisheries

Source: DETR 1999

United States of America

For the United States, two major studies of environmental indicators were examined. The first was done by the National Research Council's Commission on Geosciences, Environment and Resources. The second study was completed by the H. John Heinz III Center for Science, Economics and the Environment.

Commission on Geosciences, Environment and Resources

In response to a request made by the U.S. Environmental Protection Agency to identify criteria for evaluating biological indicators, the National Research Council created the Committee to Evaluate Indicators for Monitoring Aquatic and Terrestrial Environment. The Committee focused on reviewing the ecological indicators used in the EPA's Environmental Monitoring and Assessment Program (EMAP) and on the needs of other monitoring programs by federal and state agencies.

The goals of the report are to:

- Suggest criteria for selecting useful ecological indicators;
- Provide methods for integrating complex ecological information into indicators that summarize, in simple but powerful ways, conditions and changes in important ecological processes and products;

- Propose indicators that meet the suggested criteria;
- Identify sources of data that can be used to design and compute the numerical value of indicators; and
- Offer guidance for gathering, storing, interpreting, and communicating information form ecological monitoring.

Because many environmental policies occur at the national level and many international agreements need national-level information to establish international standards, the committee focused on those indicators that are potentially useful at a national level. It developed a checklist of twelve criteria for evaluating the indicators, which included their general importance, reliability, statistical properties, data requirements, skills required to collect data, and international compatibility. Additionally, the committee used a conceptual model of the factors that most strongly influence ecosystem functioning (i.e., productivity and native and exotic species).

Based on the criteria and conceptual module, the committee recommended the following three categories of national ecological indicators:

- *Extent and status of the nation's ecosystems*—land cover (includes aquatic and dryland ecosystems) and land use;
- *Nation's ecological capital*—total species diversity, native species diversity, nutrient runoff, and soil organic matter; and
- *Ecological functioning or performance*—carbon storage, production capacity, net primary production, lake trophic status, stream oxygen, and for agricultural ecosystems, nutrient-use efficiency and nutrient balance.

While much of the information, required as input for the listed indicators, is being collected at regional scales (and even in some cases at national scales), full development of the indicators will be time and money intensive. Due to the resources needed, the committee has recommended a sequential approach to the development and implementation of the indicators, with land-cover being implemented first.

H. John Heinz III Center for Science, Economics and the Environment

In 1995, the H. John Heinz III Center for Science, Economics and the Environment was asked by the White House Office of Science and Technology Policy to provide a comprehensive, consistent and reliable source of information about the state of the United State's ecosystems. In 1999, the Heinz Center published their draft report *Designing a Report on the State of the Nation's Ecosystems: Selected Measures of the Condition of Croplands, Forests and Coasts & Oceans*.

The Heinz Center's strategy for developing properties and measures of the above ecosystems included an iterative approach involving the Design Committee, technical work groups and outside collaborators. The Design Committee produced an initial set of reporting measures, which were reviewed by an ad-hoc group of Stanford University ecologists and the Chair of the national Research Council's Committee on Indicators for Monitoring Aquatic and Terrestrial Environments. These initial measures fostered an iterative discussion with the technical work groups for evaluating the feasibility and appropriateness of the measures and organizing the framework of the 12 major ecosystem goods, services and properties. Further discussions between the Design Committee, technical work groups and outside collaborators finalized the set of reporting measures.

The 12 ecosystem goods, services or properties were used to describe the use and condition of the ecosystem. The properties were then categorized into three broader aspects that included the system dimensions (amount and configuration of the system), the human uses (how people use the system, including food production and recreation), and the ecosystem condition (the status of plants and animals, the movement of chemicals, etc.). Under the broader headings, the 12 properties include:

- System dimensions: extent, landscape, and management and stewardship;
- Human Uses: food and fiber, and recreation and other uses; and
- Ecosystem Condition: plant growth and productivity, physical conditions (soil and water), nutrients, chemical contaminants, biological community condition, native species, and biological invasions, outbreaks and disease.

While previous studies on the conditions of coastal and oceanic ecosystems have proven invaluable, they have been conducted on the local and regional levels and are often sectoral in nature. The strength of the Heinz Center report is its effort to create a national picture of the state of these ecosystems. Unfortunately for the

coastal and oceanic ecosystems, the availability of data for many of the measures is non-existent (see Table 3-17), (measures for which data is unavailable are marked with an asterisk). The national picture is therefore, only as comprehensive as the available data. Additionally, the report relies heavily on examples to illustrate the measures proposed for reporting. Another weakness of the report is the limited definition of the "coastal zone." The Heinz Center team "have chosen a narrower strip of land [in comparison to other studies that include areas with significant populations that affect the coast] in order to highlight the condition of the coasts themselves rather than the sources of the pressures that may affect these areas."

Table 3-17 *Measures included in the three broader categories in the Coasts and Ocean section of Designing a Report on the State of the Nation's Ecosystems*

Dimensions	Proposed measures	Indicators
System	Extent and Habitat	Area occupied by five key habitat types, for each major region of the U.S. coast Degree of erosion of coastal lands
	Landscape Patterns	Proportion of the coastline that is natural habitat versus developed land Size of habitat patches, and the distance between them, for key habitat types in each region*
	Management and Stewardship	Acreage of coastal water off limits to all fishing Acreage and locations where oil and gas activities are prohibited, allowed, or ongoing Location of coastal and marine protected areas Area of coastal waters and watersheds with increased limits on pollutant loading*
Human Use	Food and fiber (fishing)	Amount of fish and shellfish caught commercially each year Amount of fish caught recreationally each year Top five species landed, by weight, in each region Level of bycatch, or incidental mortality*
	Recreation and other uses	Coastal recreation visitor-days and levels of participation in key recreational activities Extent of beach water quality monitoring, and the number of beaches closed due to poor water quality Acreage of shellfish growing areas with harvest restrictions resulting from pollution Proportion of each state's coast that is publicly owned
Ecosystem Condition	Plant growth and productivity	Concentration of chlorophyll Concentration of dissolved oxygen
	Nutrients/ Physical conditions	Concentration of nitrogen and phosphorous* Salinity Sea surface temperature
	Chemical contaminants	Contaminants in mussels and oysters Contaminants in sediments
	Biological Community Condition	Key species: - Species that provide habitat - Fish communities - Key consumers/ predators - Bottom-dwelling species Habitat zones or types: - Shoreline/intertidal* - Shallow subtidal - Estuaries - Offshore/deep water* - Coral reefs

(continued on the next page)

Dimensions	Proposed measures	Indicators
Ecosystem condition	Native species	• Marine mammals • Seabirds • Sea turtles • Commercially important fish
	Invasions and disease	• Number and type of nonnative species introduced into U.S. waters • Rates of fish diseases and other abnormalities • Number and extent of harmful algal blooms

3.5 Selected examples of environmental indicators at the local level

This report examined four program/project/local initiatives. The first, by the World Bank, creates indicators that measure the performance of project objectives. The remaining initiatives are at the local level: Nova Scotia, Canada; Kent County, United Kingdom; and Florida, United States.

World Bank

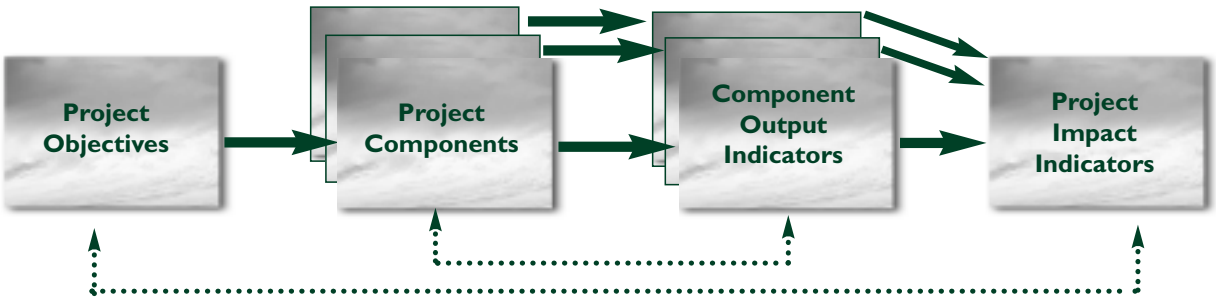
In 1999, the World Bank published the Second Edition of Environmental Performance Indicators (EPI). This document discusses how to structure indicators within a logical framework, how performance indicators are developed in general, how to link them to the objectives at different levels, and how they affect the World Bank's projects in relation to environmental issues.

The framework is a project indicator framework based on the Input-Output-Outcome-Impact model. The input indicators monitor the project-specific resources provided. The output indicators measure the goods and services provided by the project. Outcome indicators measure the immediate, or short-term, results of project implementation. Finally, impact indicators monitor the longer-term or more pervasive results of the project. See Figure 3-3 for a schematic of the Input-Output-Outcome-Impact model.

The process of selecting the indicators involves a set of criteria that answers questions about the direct relevance to the project objectives, limitation in number, clarity in design, realistic collection or development costs, clear identification of causal links, high quality and reliability, appropriate spatial and temporal scale, and targets and baselines.

The uses of the EPIs include the ability to compare them to benchmarks, to examine variations in the indicator over time, and to contrast the outcome of the project with what would have happened in absence of the project.

Figure 3-1 *World Bank Input-Output-Outcome-Impact framework model.*
(Note: Dotted lines denote linkages between objective or component and its corresponding indicator)



This logical framework is the World Bank's real strength. Unfortunately, this process is dependent on benchmarks, control groups, collection of trend data, and statistical techniques in order for it to be useful.

Florida, Unites States of America

In Florida, the Coastal Management Program has produced a set of coastal indicators published in the Florida Assessment of Coastal Trends (FACT). The most recent edition, FACT 2000, catalogues and describes ecological, socioeconomic and governmental indicators in several aspects of coastal resource management: coastal hazards; coastal access; community involvement; economic development; habitat and biodiversity; land acquisition; land use; outreach and education; tourism and recreation; and water quality.

In selecting the FACT 2000 indicators, consideration was given to how well an indicator might address the goals of a particular focus area. Other important criteria used in selecting these indicators include quality of data (reliability, validity and availability), the potential for trend analysis, and appropriateness of scale.

Once again, there were gaps in data for some indicators such as water quality and manatee populations. Additionally, Florida does not have a framework that will allow for better understanding and comparison between other indicators at the national and international levels, such as the PSR framework.

Nova Scotia, Canada

To create a new approach in selecting indicators for measuring trends in sustainable use and environmental quality in Canada, the Nova Scotia Genuine Progress Index (GPI) Fisheries and Marine Environment Accounts proposed a new framework on the local level that can be applied to the national level.

This approach arose as a result of the recognized need to develop a set of measures that better reflect the reality of what is valued and that more accurately assess the well-being of the fishery and the marine environment. The Fisheries and Marine Environment Accounts are a portion of the larger GPI measures of Nova Scotia that estimate its natural and social wealth. Each indicator in this account measures one particular aspect of the marine system, dealing with the ecosystem, socioeconomic progress, the well-being of communities, and the institutional integrity of fishery and ocean management. As such, the indicators are organized into three categories: ecological indicators, socioeconomic and community indicators, and institutional indicators. The second and third type of indicators will be talked about in Chapters 4 and 5, respectively. The Ecological Indicators are listed below in Table 3-18.

A primary strength of this GPI approach employed by Nova Scotia, is its construction of a comprehensive picture that recognizes the complex interconnections within the marine ecosystem and among the humans reliant on that ecosystem. This overview is accomplished particularly by incorporating fisheries data with other ocean uses. However, gaps in available data and data limitations serve as a weakness, which that has been prevalent in other studies as well.

Table 3-18 *Ecological indicators in the GPI Fisheries and Marine Environment Accounts*

Ecological indicator categories	Individual indicators
Primary Commercial Species	• Fishable Biomass • Catch Levels • Size at Age • Condition Factor • Age Structure
Non-Targeted Species	• Discard Rates • Right Whales: Population and Reproduction
Resilience and Biodiversity	• Shannon-Weiner Index • Area of Bottom Habitat Impacted
Marine Environmental Quality	• Organochlorine contaminants in Seabird Eggs • Contaminants in Mussels • Area of Shellfish Closures

Kent County Council, United Kingdom

The Kent County Council has established a Coastal Observatory to facilitate data collection and maintenance. This observatory serves as a hub for all information pertaining to the coastal zone. While many organizations may collect the data, it is stored at the observatory on their behalf. The subsequent synthesis and integration of data and information enables consistent reporting on patterns and trends in management and resources.

This work represents the first local attempt in the United Kingdom at developing a system of coastal indicators. Some examples of their themes and indicators, published in the "Sustainability of Kent Coast and Seas," include:

- *Nature Conservation and Biodiversity*—areas of important coastal habitats and designated protected areas;
- *Coastal Processes*—coastal defenses;
- *Resource Use*—fish stocks and landings; and
- *Pollution*—treatment of sewage and contaminants in coastal waters.

3.6 Summary and selected list of environmental indicators

Environmental indicators applicable to the coastal zone have been developed within the context of large-scale research programs at the global level and are used in the framework of state of the environment reports at the national level, and eventually within regional initiatives. Typically, environmental indicators are developed within the PSR framework or extended models and are useful to monitor the state of the coastal and marine environment.

Environmental indicators tend to be physical or biological in nature, rather than being oriented towards management processes. Many countries are now putting more effort into the development of indicators that would allow an assessment of the sustainability of current or planned uses of the coastal zone.

Table 3-19 *Summary of indicators for environmental state*

● Explicitly and currently used
❍ Implicitly or no longer used

Theme	Indicator	Level	UN	OECD	WRI	EEA	BP	Other
Shoreline stabilization	Percentage of the coastline subject to erosion processes	National		●	●	●	●	
Water quality	Eutrophication	National Local Spot	❍	●	●	●		
	Algae concentration in coastal waters	National Local Spot	●		●		❍	
	Discharge of heavy metals	National Spot				●	❍	
	Oil pollution at coast and at sea	National	❍		●	●		
	Discharge of halogenated compounds	National			●	●		
	Faecal pollution	National				●	❍	
	Bathing water quality	National Local Spot	❍		❍	❍	❍	
	Solid waste on beaches/seabed	National Local				●	●	
Biodiversity, habitats, and landscape	Loss of priority habitats	National Local Strip		❍	●	●		
	Threatened or extinct species as % of known species	National		●	●			
	Loss of wetlands	National		❍		●		

The following criteria were used to create a parsimonious list of environmental indicators (see Table 3-12). Each environmental indicator from the comprehensive list, presented in the summary, was evaluated according to its:

- Usefulness and policy relevance; relevance to ocean and coastal zones; sensitivity to changes in ocean and coastal zones; ease of interpretation (for dissemination to broader audiences); usefulness to ocean and coastal managers (decision-makers); national scope; and ability to establish baselines and targets.
- Data considerations: availability of data; ability to measure/collect data consistently (regular updates, sufficient documentation); soundness of data (scientific foundation, international consensus).
- Outcome versus output-based approach.
- Ability to aggregate at all levels.
- Ability to forecast future problems.
- Ability to provide clear indication of causal links.
- Appropriateness of spatial and temporal scales.

The following initial categories of environmental indicators, particularly relevant to integrated coastal management, are proposed:

- Coastal Zone Extent and Characterization;
- Biodiversity;
- Tourism;
- Fisheries;
- Marine Environmental Quality;
- Shipping;
- Oil and Gas; and
- Global Processes.

Recognizing that characteristics of coastal and marine areas vary according to region, country, and locality, the suggested environmental indicators were kept as broad as possible to allow for such differences.

Table 3-20 *Selected list of environmental indicators*

ICM characteristics	Indicator
Coastal Zone Extent and Characteristics	Coastal population: % population living in coastal areas; human population within 100 km of coast; coastal population density; population growth in coastal areas etc.
	Relevant coastal habitats: area (e.g., beaches/dunes, intertidal reefs, intertidal sand/mud flats, mangroves, seagrasses, saltmarshes, estuaries, algal beds, coral reefs, etc.) and loss of habitat area
	Coastal zone extent
	Natural vs. altered land cover within 100 km of coastline
	Coastline erosion
	Area of land owned by public and public access areas
	Area of protected coastal areas and marine protected areas
Biodiversity	Percent cover of key coastal habitats (e.g., dune vegetation, coral reef, intertidal reef, saltmarsh, mangrove, seagrass, etc.)
	Species inventory of key coastal habitats
	Disturbance of benthic communities
	Rare, endangered, protected and/or threatened coastal and marine species
	Threats to habitat and ecosystem structure
	Alien species
Tourism	Tourism intensity: number of tourists per km of coastline; tourist arrivals; coastal recreation visitor days, etc.
Fisheries	Annual catch of major fish species (recreational and commercial): size and numbers
	Level of bycatch or incidental mortality
	Change in trophic composition of fish catch
	Level of overfishing
	Shellfish: commercial and recreational catch of shellfish
	Seafood quality (contamination): contaminants in fish and mollusks

ICM characteristics	Indicator
Water quality	Physical parameters: salinity, turbidity/sedimentation, pH
	Solid waste parameters: accumulation on beach; disposal density at sea
	Heavy metal and POP parameters: accumulation in organisms, discharges of heavy metals
	Eutrophication parameters: algal bloom events, occurrence of hypoxic zones, nutrient levels, dissolved oxygen, Chlorophyll-a levels, etc.
	Halogenated organic compounds: discharges and levels
	Faecal pollution: discharges and levels
	Pathogens, biotoxins, and disease agents: discharges and levels
Shipping	Amount of shipping traffic
	Harbor equipment ratio
Oil and Gas	Oil tanker traffic levels
	Oil spills-frequency and volume
Global Processes	Sea surface temperature variability
	Sea level changes

4. Socioeconomic pressures and benefits: socioeconomic indicators

4.1 Introduction

In the ordering of coastal governance outcomes, environmental and socioeconomic outcomes are achieved after institutional and behavioral outcomes have been attained (Olsen, Tobey and Hale 1998). Theoretically, improvements in social and environmental indicators culminate in sustainable environmental quality and quality of life that are achieved through time. From the perspective of the PSR and DPSIR frameworks, the effective management of anthropogenic pressures affecting the coastal zone would result in improved quality of the environment and reduction of impacts. This, in turn, should yield socioeconomic benefits in the longer run. The challenge is to develop appropriate sets of both environmental and socioeconomic indicators that will allow decision makers to determine whether management interventions addressing coastal and ocean issues are achieving their intended goals. Socioeconomic indicators are a powerful means to represent the state of the human component of coastal systems (i.e. demographic data, social/cultural populations, etc.) as well as a tool in the development and implementation of ICM strategies, programs and projects.

A review of worldwide practices in the use of indicators to monitor the progress of ICM conducted for the Scottish Executive Central Research Unit revealed many good examples of indicator sets for measuring the state of the coastal zone. These sets, however, have concentrated on the state of the coastal environment with little consideration for the economic or social aspects of a sustainable coastline (Cordah Ltd. 2001). One probable reason for this is that most sets of indicators follow the PSR framework (OECD 1993; OECD 1997) which does not lend itself well to identifying social or economic indicators. In the PSR framework, 'state' indicators describe the environmental condition, the quantity and quality of natural resources, excluding the human dimension.

An aspect that is increasingly recognized in terms of linking environmental and socioeconomic aspects, is the number of diseases and infirmities associated with contaminated marine water, fish and other species. Diseases can be an important biological indicator (HEED 1998). The rise in marine-related diseases in the U.S. Atlantic coast, the Gulf of Mexico, and the Caribbean suggests that coastal conditions conducive to illness are widespread, particularly among seagrasses and coral reefs. Human risks are posed by seafood consumption and recreation (GESAMP 2001). This can lead to important economic losses for seafood industries, fishing communities, trade, travel and tourism. The establishment of coordinated disease monitoring and environmental surveillance systems, for example for harmful algal blooms (HABs), could provide a useful tool to monitor changes in marine ecosystems.

The assessment of integrated coastal area management initiatives in the Mediterranean (METAP 1998) did not specifically look into socioeconomic impacts although the following socioeconomic dimensions are mentioned in the results, emphasizing the need for the rational application of socioeconomic indicators in ICM:

- Population issues are not always adequately taken into consideration;
- Human activities have been treated in an adequate way although the emphasis has been on tourism;
- Urbanization and land-use conflicts are present in most cases but fail to be satisfactorily integrated into management policies; and
- Human impacts on natural ecosystems have been treated in a satisfactory way but economic analyses of environmental impacts are generally lacking (METAP 1998).

The examples that follow are socioeconomic indicators which are part of broader and more comprehensive State of the

Environment Reports. These may either form part of a single coastal marine theme within these SERs, or indicators that are broader in scope and not limited to the measurement of socioeconomic conditions of the coastline, though nonetheless applicable. Examples of socioeconomic indicators from coastal management programs at various levels are also mentioned.

4.2 Selected examples of socioeconomic indicators at the global level

United Nations

Indicators for sustainable development

At the global level, the UN methodological guidelines on indicators for sustainable development (United Nations and World Bank 2001) include the percentage of total population living in coastal areas and the annual catch by major marine species as the two main pressures on the coastal area. In the testing exercise developed, only one country (South Africa) included the population growth in the coastal area.

The United Nations Atlas of the Oceans

The United Nations Atlas of the Oceans is a combined effort of several agencies of the United Nations to provide information on the sustainable development of the oceans to policy makers. Participating United Nations agencies include the United Nations Environment Programme (UNEP), the Food and Agriculture Organization (FAO), the Intergovernmental Oceanographic Commission of UNESCO (IOC), the World Meteorological Organization (WMO), the International Maritime Organization (IMO), and the International Atomic Energy Agency (IAEA). The partnership includes also the Secretariat of the Convention on Biological Diversity, the U.S. National Oceanic and Atmospheric Administration (NOAA), the Head Department of Navigation and Oceanography of the Ministry of Defence of the Russian Federation, the National Geographic, the United Nations Foundation, and the Census on Marine Life (CoML). The Atlas includes four main categories of information: (1) information on the history of the oceans, biology, maps and statistics to research, climatology and ecology; (2) uses of the oceans (from fishing, shipping and mining to tourism, dumping and marine biotechnology); (3) ocean issues (from food security and climate change to governance and human health); and (4) geography (information categorized by geographical area). The atlas, currently under development in some of the sections, presents a collection of maps, statistics and databases related to features, uses and issues in oceanic geography, islands, continental shelves, ocean depths, troughs and deep-sea beds.

The Global Marine Assessment (GMA)

Following Decision 21/13 of the UNEP Governing Council of 9 February 2001 and the adoption of the Plan of Implementation for the World Summit on Sustainable Development (paragraph 34[b]), an intergovernmental meeting will be held in 2004 in cooperation between UNEP, IOC/UNESCO, FAO, IMO, WHO, IAEA, WMO and the CBD Secretariat to arrange a regular process under the UN for global reporting and assessment of the state of the marine environment. The report will be built on ongoing assessment programs on the marine environment and will include indicators for socioeconomic aspects, both current and foreseeable.

The Global Ocean Observing System (GOOS)

A system for sustained, global measurements of a small number of common variables will form the backbone of Coastal GOOS. Selection of the common variables must follow a systematic, objective procedure that addresses the needs of users. The goal is to identify the minimum number of variables that must be measured to detect and predict changes that are important to the maximum number of user groups. Table 4-1 outlines lists used in the preliminary process for selecting common variables. These lists will be carefully reconsidered and revised during the implementation phase of Coastal GOOS.

One of the terms of reference of the Coastal Oceans Observations Panel (COOP) is to integrate and refine the design plans drafted by the Health Of The Oceans (HOTO), the Living Marine Resources (LMR), and the Coastal GOOS (CGOOS) panels to develop a unified plan that is consistent with the GOOS Design Principles. Socio-economic variables are considered in detail in the "Health of the Oceans" module of GOOS. HOTO was operationally defined for the purposes of reflecting the condition of the marine environment from the perspective of adverse effects caused by anthropogenic activities, in particular the mobilization of contaminants.

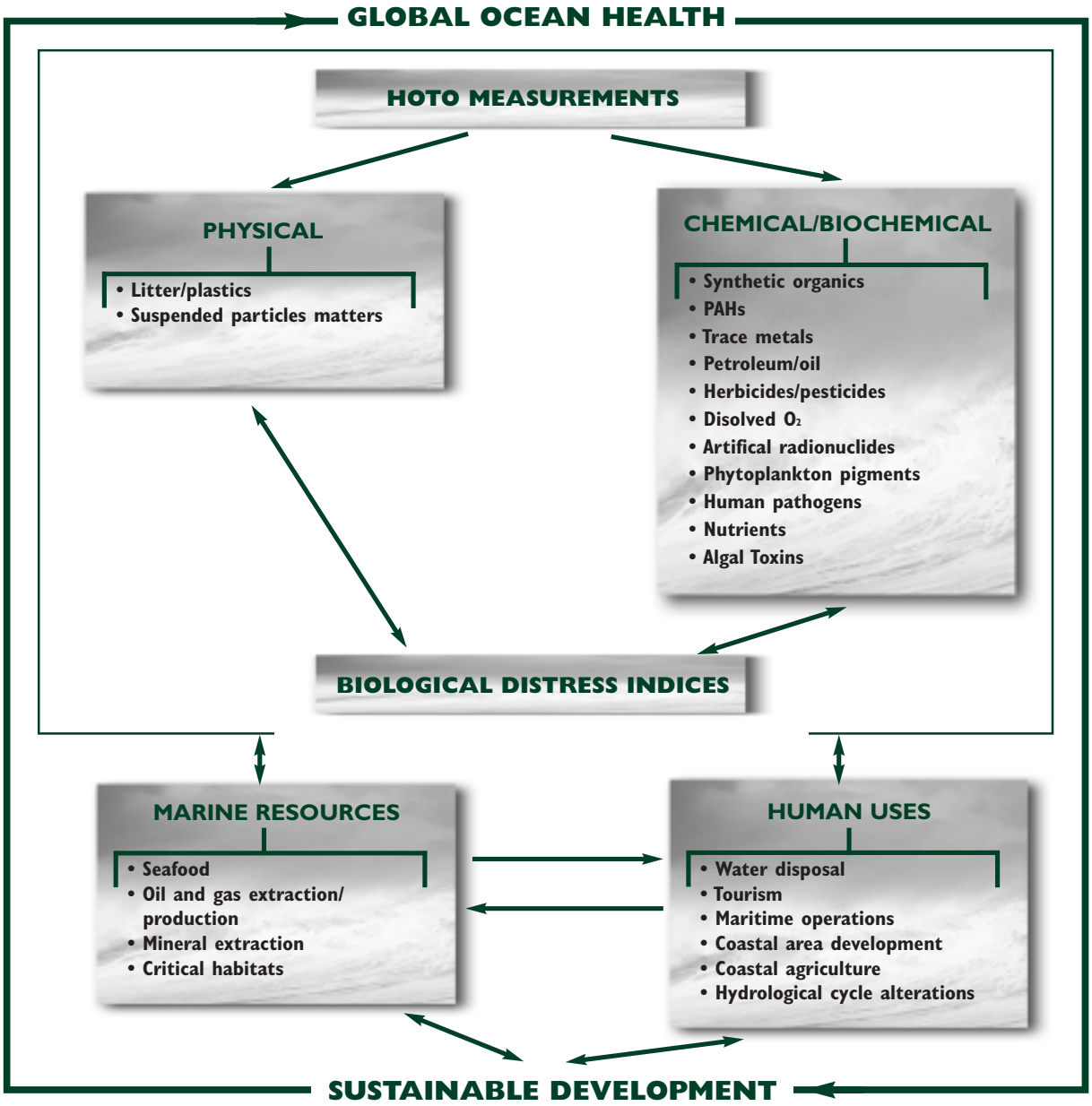
The systematic monitoring carried out under HOTO is intended to contribute further to: i) an understanding of the status and future trends in ocean health and human health; and ii) the ability of state governments to maximize socio-economic benefits derived from sustainable

development of ocean/coastal areas. The relationship between marine resources, human uses and the HOTO indicators of global ocean health are shown in Figure 4-1. As mentioned above, the HOTO panel of GOOS will now be replaced by the COOP.

Table 4-1 *GOOS variables*

User groups	Phenomena of interest	Variables to detect or predict change	Predictive models
• Shipping • Oil and gas • Insurance and reinsurance • Coastal engineers • Fishers (commercial, artisanal, and recreational) • Agriculture • Mining • Aquaculture • Fisheries management • Search and rescue • Port authorities and services • National weather services and private sector weather services • Land-use planners and developers • Government agencies responsible for environmental protection • Public health authorities • Navies • Coastal area management • Emergency management agencies and the Red Cross/Crescent • Coastal communities (indigenous people, artisan populations) • Tourism • Conservation and amenity (including environmental NGO's) • Consumers of seafood • Recreation • News media • Educators • Scientific community	• Sea state • Shoreline changes and coastal flooding • Surface currents • Changes in sea level • Changes in shallow water bathymetry • Chemical contamination of seafood • Human pathogens • Habitat modification and loss • Eutrophication • Changes in biodiversity • Oxygen depletion • Harmful algal events • Invasive species • Changes in water clarity • Disease and mass mortalities in marine organisms • Chemical contamination of the environment • Fisheries harvest • Aquaculture harvest • Abundance of exploitable living marine resources	• Attenuation of Solar Radiation • Bathymetry • Biological Oxygen Demand • Currents • Dissolved Inorganic Nutrients (N, P, Si) • Dissolved Oxygen • Fecal Indicators • Incident Solar Radiation • Macrobenthic Abundance • Meiobenthic Biomass • Nekton Biomass • pH • Phytoplankton Biomass (Chlorophyll) • Primary Production • Sea Level • Sea Surface • Temperature • Sediment Grain Size and Organic Content • Surface Salinity • Surface Waves • Total Organic C and N • Total Suspended Solids • Zooplankton Biomass	• Coastal flooding (hours to days) • Extreme weather (hours to days) • Coastal erosion (seasons to years) • Trajectory of spill or navigation hazard (hours to days) • Search and rescue trajectory (hours to days) • Sea-level rise (years) • Coastal currents and sea level (hours to days) • Sediment transport/bathymetry (seasons to years) • Extent and duration of hypoxia/anoxia (seasons to years) • Occurrence/distribution of harmful algal events (days) • Effects of climate change on benthic communities (years) • Habitat loss (e.g., mangroves, coral reefs) (years) • Water quality – nutrient enrichment (seasons to years) • Spread of water-borne disease (seasons to years) • Aquaculture: maximum sustainable finfish stocking density (seasons to years) • Aquaculture: shellfish carrying capacity (seasons to years) • Fisheries: maximum sustainable harvest • Fisheries: stock assessment (years) • Spread of disease in marine organisms (seasons to years)

Figure 4-1 *Relationship between Global Ocean Health and Sustainable Development*



Millennium Ecosystem Assessment (WRI 2001)

In WRI's Millennium Ecosystem Assessment, selected indicators on the condition of the world's coastal zone included socioeconomic indicators in three out of six categories (Table 4-2).

Table 4-2 *WRI indicators for the Millennium Ecosystem Assessment*

Issue	Indicators
Extent of and change in the coastal zone	• Human population within 100 km of coastline
Biodiversity	• Conservation values
Tourism and recreation	• Value of tourism and employment in the tourism sector • Importance of tourism to the economy • Tourist arrivals • Equitable distribution of tourism benefit—leakage of tourism revenue

World Commission on Protected Areas (WCPA) Marine

The World Commission on Protected Areas (WCPA)Marine, working with Global Coral Reef Monitoring Network (GCRMN) and its sponsors (UNEP, IOC, IUCN-Marine Programme), has developed a Coral Reef Socioeconomic Assessment Manual to provide practical guidelines on how to conduct socioeconomic assessments of coral reef resources. The Manual was developed to help managers better understand human communities, so that they can more effectively incorporate stakeholder concerns into the management process, determine the effects of management decisions on coastal communities, and demonstrate the value of the reef resources to the general public, stakeholder groups and policy-makers.

The manual describes an extensive list of socioeconomic parameters and associated subparameters and indicators for the assessment. Table 4-3 provides an example of one of many subparameters of the parameter for Resource Use Patterns with associated questions and indicators. Categories of parameters described in the manual include:

- Resource use patterns (Reef-related activities, techniques for reef-related activities, use rights etc.)
- Stakeholder characteristics (Inhabitants and households, Residency status, Age and gender, Household economic status, etc.)
- Gender issues
- Stakeholder perceptions (Reef conditions, Threats to the reefs, Reef management, etc.)
- Organization and resource governance
- Traditional knowledge
- Community services and facilities
- Market attributes for extractive uses of reefs
- Market attributes for non-extractive uses of reefs
- Non-market and non-use values

Table 4-3 *Parameter-resource use patterns from the Coral Reef Socioeconomic Assessment Manual*

Sub-parameter	Questions	Indicators	Unit of measurement
Reef-related activities	What reef-related activities are taking place on land?	Identification of land-based activities	Uses and associated reef resources
	What reef-related activities are taking place at sea?	Identification of sea-based activities	Uses and associated reef resources
	What impacts are these activities having on reef resources?	Types and levels of change	Types, levels

The manual is being complemented by regional and national training workshops around the world to help reef managers incorporate socioeconomic assessments and monitoring into their reef management programs.

As an example, the indicators for resource use patterns and market attributes for extractive uses are presented in Table 4-4

Table 4-4 *Examples of indicators from the GCRMN socioeconomic manual*

Parameter	Sub-parameter	Indicators
Resource use patterns	Reef-related activities	• Identification of sea-based activities • Identification of land-based activities • Types and levels of damage
	Reef stakeholders	• Types of stakeholders • Number • Basic characteristics

(Continued on next page)

Parameter	Sub-parameter	Indicators
	Techniques for reef-related activities	• Techniques • Technologies, equipment • Construction, ownership, costs • Effects on reefs • Types of enterprise, forms of ownership, distribution of benefits
	Use rights	• Forms of ownership/use rights • Rules, regulations, laws • Effects
	Location of reef-related activities and stakeholders	• Location
	Timing seasonality	• Seasonality • Explanation
Market attributes for extractive uses	Supply	• Type of extractive use • Reef organisms harvested • Reef products harvested • Uses of reef products • Amount • Value • Species (local/scientific names) • Month/season • Stability of supply
	Demand	• Primary market outlet • Market orientation • Local, national, regional, international • Ready markets for products • Community location • Periods of changing demand • Stability of demand
	Market prices	• Who sets prices • Factors in price setting • Price information • Price adjustment • Location of market
	Market structure	• Number of producers operating • Percentage of resident producers • Number of traders • Ratio of producers to traders • Concentration • Market channels • Marketing groups • Buying and selling practices • Observed unethical practice • Presence of credit/marketing relationship • Operation of relationship • Produce free to set selling price • Credit
	Market infrastructure and operation	• Market orientation • Market services • Market rules

Source: Bunce et al. 2000

4.3 Selected examples of socioeconomic indicators at the regional level

Socioeconomic costs and benefits of ICM in the EU

In 2002, the EU commissioned a study on the socioeconomic costs and benefits associated with ICM, based on the experience of the Demonstration programme on ICZM (Firn Crichton Roberts Ltd. 2000). The study, conducted on 35 European ICM pilot projects, was based on three main evaluations:

1. An estimate of the value of the environmental goods and services provided by the coastal biomes present in European coastal zones (based on Costanza et al. 1997);
2. A study of the main economic activities in the coastal zones and the associated environmental problems; and
3. An assessment of the perceived socioeconomic and institutional benefits associated with different levels of investments in ICM infrastructures (Table 4-5).

The study yielded two sets of qualitative socioeconomic benefits: (a) the socioeconomic changes leading to the evolution of sustainable coastal communities; and (b) the institutional and procedural changes, which enable such improvements to take place.

Table 4-5 *Perceived benefits in 35 ICM demonstration projects*

Perceived benefits	No. initiatives with benefits	Total ranking points by ICM initiative	Average ranking by ICM initiative
More coherent spatial planning	23	96	4.17
Improved decision making	30	126	4.20
Better partner understanding	28	127	4.53
Achieved agreement on priorities	25	103	4.12
Stronger community feeling	22	93	4.23
Reduced traffic costs	5	15	3.00
Better quality of life	15	56	3.73
Reduction in pollution	13	46	3.53
More sustainable fisheries	13	43	3.30
More sustainable tourism	22	93	4.22
Habitat restoration	17	65	3.82
Reduced flooding & erosion	8	32	4.00
Lower environmental vulnerability	15	57	3.80
Greater public awareness	28	117	4.18
School & education initiatives	20	91	4.55
Landscape improvement	15	57	3.80
Others	2	6	3.00
Total	301	1,223	4.06

Socioeconomic benefits directly associated with ICM have not been measured by the pilot projects. Benefits, however, were generally reported for three main areas: (a) habitat protection, (b) local infrastructure and business, and (c) coastal tourism. Therefore, the study attempted to estimate such benefits based on flows of value for each of these areas, as follows:

- *Habitat protection benefits* were calculated using average values for each biome type (Table 4-6, Costanza et al. 1997), considering the extension of such biomes in the coastal zones of the different EU countries.
- *Local infrastructure and business benefits* were calculated taking national gross domestic product (GDP), subtracting the contribution to GDP from tourism, and estimating the value of GDP generated at the coast (5%) (Table 4-7).
- *Coastal tourism* was calculated assuming a percentage of GDP from tourism directly benefiting coastal actors (10%).

Table 4-6 *Derivation of non-market values of ecosystem services*

Biome type	Total ecosystem services	Market value deductions		Non-market ecosystem services
	Value	Food	Recreation	Value
Open Ocean	25.2	1.5	-	23.7
Estuarial Waters	2,283.2	52.1	38.1	2,193.0
Sea Grass	190.0	-	-	190.0
Continental Shelf	161.0	6.8	-	154.2
Tidal Marshes	999.0	46.6	65.8	886.6
Swamps & Flood Plains	1,958.0	4.7	49.1	1,904.2
Lakes & Rivers	849.8	4.1	23.0	822.7
Temperate Forests	30.2	5.0	3.6	21.6
Grasses & Rangeland	23.2	6.7	0.2	16.3
Rock/Ice	-	-	-	-
Cropland	9.2	5.4	-	3.8
Urban Areas	-	-	-	-
Other Areas	10.0	-	-	10.0

Source: Costanza et al. 1997
Values are thousands of US Dollars, per square km, per year.
Ecosystem services used to derive the ecosystem services values are: gas regulation, climate regulation, disturbance regulation, water regulation, water supply, erosion control and sediment retention, soil formation, nutrient cycling, waste treatment, pollination, biological control, refugia, food production, raw materials, genetic resources, recreation, cultural.

Table 4-7 *Estimated annual value of ICM economic benefits*

EU coastal countries	Annual value of ICM economic benefits (€ million 1998)			
	% Biomes	% Industry	% Tourism	Total
United Kingdom	10.0	77.2	12.8	883.4
France	4.3	82.0	13.7	782.1
Italy	4.0	84.0	12.0	711.2
Sweden	31.0	62.4	6.6	163.8
Spain	8.6	65.9	25.5	392.4
Finland	32.2	65.6	2.2	98.3
Germany	2.3	86.1	11.6	450.6
Eire	39.2	50.4	10.4	65.3
Netherlands	7.9	82.8	9.3	209.9
Denmark	14.3	77.0	8.7	119.1
Greece	7.6	74.6	17.8	124.2
Portugal	11.6	76.0	12.4	68.2
Belgium	0.6	91.7	7.7	125.4
EU total	354.4	3,293.8	546.1	4,194.4
% distribution	8.5	78.5	13.0	100.0

The estimated values were then calculated for the individual Member States and the whole EU for two scenarios of investment in ICM: a relatively Low Level of activity and commitment; and a more comprehensive and determined (High Level) investment in ICZM activities. While the estimated value of annual ICM benefits vary significantly among the different countries, the value of the annual generated ICM benefits significantly exceed the value of the associated ICM expenditure-based costs: by 13.5 times in the Low Level scenario, and by 8.6 times in the High Level ICZM scenario. This pilot study provides a very interesting case of the combination of qualitative and derived quanti-

tative measures of socioeconomic benefits of ICM. This synthesis adds to the evaluation of the coastal economic system, considered not just in terms of its pressures over the environment, but also in relation to outcomes associated to the undertaking of ICM efforts. A further phase of the study could include a project-by-project quantitative estimate of socioeconomic benefits based on common indicators and comparable across Europe.

4.4 Selected examples of socioeconomic indicators at the national level

Australia

Three classes of indicators under the estuaries and sea theme of Australia's environmental indicators (renewable products, ron-renewable products, and integrated management) include indicators that are socioeconomic in nature (Ward, Butler and Hill 1998). These indicators document various aspects of natural resource exploitation in ocean and coastal areas as well as aspects of efforts to integrate the management of estuarine and marine ecosystems. Indicators that may be classified as socioeconomic in nature are:

- Aquaculture production;
- Ocean exploration;
- Ocean mining;
- Catchment development;
- Coastal population; and
- World Heritage Area tourism.

Scotland

A report on sustainability of indicators for waste energy and travel in Scotland had two indicators that are relevant to coastal issues: (1) homes with access to the internet (for awareness raising and information dissemination); and (2) public awareness of sustainable development and waste-energy-travel issues (Cordah Ltd. 2001).

South Africa

The National State of the Environment Report groups indicators according to main issues that include social, economic, and political dimensions (Harrison and Taljaard 2001; Schwabe, Viljoen and O'Donovan 2001). Population growth and development is the only socioeconomic indicator identified for coastal and marine, and is described in Table 4-8.

Table 4-8 *South Africa: socioeconomic indicators*

Sub-category	Issue/pressure	Indicator
Development	• Trends in human pressures on marine and coastal areas	• Nature, distribution, and extent of human settlements and industry in coastal areas
Population growth/density	• Trends in human pressures on marine and coastal areas	• Population density and growth in coastal areas
Shipping Tourism/use	• Trends in human pressures on marine and coastal areas • Measure of the value of marine and coastal resources	• Ship traffic • Tourist frequency during peak periods

A list of socioeconomic issues that require monitoring along with some suggested indicators is contained in the Growth Employment and Redistribution strategy, which is the macroeconomic policy of the South African government. The issues are listed below (Table 4-9).

Table 4-9 *Socioeconomic issues in the Growth Employment and Redistribution Strategy of South Africa*

Issue	Indicator
Economic Sector	• Distribution of Gross Domestic Product • Extent of employment/unemployment • Employment growth by sector • Job creation • Productivity
Labor action and Political Stability	• Labor strikes • Political stability
Development Funding	• Fiscal transfers of Financial and Fiscal Commission • Level of finance from multilateral institutions and other international funding institutions
Tax distribution	• Extent of taxes generated within regions
Service Needs and Provision	• Education • Health • Welfare • Housing • Water and sanitation • Electricity • Wastewater and stormwater • Roads, railways, airports and harbors • Telecommunications and postal services
Education	• Education infrastructure • Pass rates • Teacher qualifications
Land Distribution	• Land distribution • Land tenure
Health	• Availability of primary health facilities • Availability of equipment and staff • Quality of medical or primary care provided by health facilities • Parasite infection and malnutrition
Welfare	• Availability of "social security net" • Availability of targeted welfare services

United Kingdom

The Environment Agency has developed a suite of approximately 70 indicators; Beach litter is one among the nine themes related to inland and coastal waters and covers lifestyles and use of resources in the UK (Cordah Ltd. 2001).

The Department of International Development (DFID) of the UK Government annually publishes the Statistics on International Development, which reports on development progress in individual aid recipient countries and on the deployment of official UK financial resources to support such progress. The report contains indicators of developmental progress, which covers the following items: income; poverty; education (including gender equality); health and population; environment and infrastructure; international economic linkages and national economic indicators; and indicators related to globalization issues.

United States of America

In the Heinz Center's *Coastal Management Performance Measures and Indicators* (Heinz Center, Draft of March 2002), developed to evaluate the effectiveness of state coastal zone management program activities in achieving the objectives of the U.S. Coastal Zone Management Act (CZMA), three out of six focus areas included socioeconomic dimensions (which describes what needs to be measured) (see Table 4-10).

Table 4-10 *Indicators to measure the effectiveness of the U.S. CZMA*

Issue	Indicators
Public access	• Legal availability (legal mechanisms ensuring public access) • Access points (description of types of physical access and areas of access points) • Quality of experience (description of the usability of the public access points and state of surrounding environment)
Coastal community development	• Environment and land use (description of types of land development in the coastal areas) • Economic (description of economic diversity and positive and negative economic growth) • Social (description of engagement between government and the public) • Public investment and infrastructure (description of alignment between investments and incentives shaping)
Coastal hazards	• Mitigation, response and recovery (of property owners and government to hazards)
Coastal dependent uses	• Planning and management mechanisms (description of the authority to enact laws and ordinances to protect public health, safety and welfare) • Economic health (measure in physical economics or types of uses and trends in economic development)

4.5 Selected examples of socioeconomic indicators at the local level

Kent County, United Kingdom

The system of coastal indicators developed for Kent County (Cordah Ltd. 2001) included themes that directly or indirectly include socioeconomic aspects, 1) including land use and development, 2) tourism and recreation, 3) resource use, 4) traffic, transport and shipping, and 5) socioenvironmental quality. Examples of indicators under the last theme are deprivation in coastal districts, health in coastal districts, rate of crime in coastal districts, and town centre vitality.

Living Coastlines Project, United Kingdom

A framework for managing the coast of Devon and Cornwall (Cordah Ltd. 2001) included socioeconomic indicators from among five out of ten themes, as summarized in Table 4-11.

Table 4-11 *Indicators in the Living Coastline Project, U.K*

Issue	Indicator
Economic development/ resource use and efficiency	• Diversity of the industrial base on the coast • Levels of local investment rates • Proportion journeys taken by public transport • Proportion of development projects taking place on brownfield land as opposed to greenfield land
Tourism/recreation	• Trends in the use of the coastal zone in relation to economic value • Numbers of car parking spaces and income from these • Numbers of hotels, bed and breakfasts, guest houses, (+bed spaces) • The number of recreational amenities/opportunities (+access for the disabled) • Intensity of use of recreational activity (land and water based)
Awareness and participation in decision making	• Level of personal involvement in community groups • Awareness of sustainability issues and Local Agenda 21
Communication and information transfer	• Proportion of population with internet access • Internet access in public libraries • Number of computers in schools • Proportion of population with a personal computer
Quality of life in the coastal zone	• Unemployment levels (seasonal) • Perceived quality of coastal landscape • Perceived 'quality of life' • Availability of affordable housing • Population age structure

Florida, United States of America

In the Florida Assessment of Coastal Trends, four out of six focus areas include socio-economic indicators (FCMP and FDCA 2000). This trend may be explained by the fact that indicators were set to assist, among specific activities of the Florida Coastal Management Program, in the monitoring of environmental and social conditions in the coastal zone, which may be the results of actions of the Program. Table 4-12 describes these socioeconomic indicators.

Table 4-12 *Indicators in FACT*

Issue	Indicators
Biodiversity and natural areas	• Economic benefit of Florida state park system lands managed for conservation and recreation
Coastal hazards	• Population in coastal high hazard areas • Emergency evacuation shelter demand and capacity • Level of awareness of coastal hazards • Number of reported vessel incidents • Land acquired for hazard mitigation
Community stewardship	• Number of people involved in stewardship organizations and activities • Level of awareness of coastal issues • Conservation license plate sales • Businesses participating in stewardship activities • Participation in volunteer activities that protect/restore and enhance coastal resources • Florida Coastal Management Program competitive grants
Waterfront revitalization	• Amount of citizen time and dollar donations to Waterfront Florida activities • Number of volunteers contributing time to activities associated with Waterfronts Florida • Public dollars invested in Waterfronts Florida communities • Private sector economic investment in Waterfronts Florida communities • Number of community goals achieved (FCMP and FDCA 2000)

4.6 Summary and selected list of socioeconomic indicators

The following observations are gathered on the use of socioeconomic indicators based on the above examples:

1. Examples of socioeconomic indicators intended to describe socioeconomic conditions in the coastal zone are rare at the national level. In State of the Environment Reports, socioeconomic indicators are developed for broader application and subnational programs are expected to come up with specific socioeconomic indicators under various themes including coasts and oceans, based on issue focus that varies from country to country.

2. It is also a possibility that examples of well-developed socioeconomic indicators for the coastal zone are rare either because monitoring and evaluation systems are not developed at the onset of project planning (see assessment of METAP and MAP projects) or are developed but did not intend to cover the measurement of impacts.

3. Issue-specific global programs such as the Millennium Ecosystem Assessment and the WCPA-Marine program which follow an integrated approach or perspective with a focus on ecosystems and marine protected areas, respectively, have developed socioeconomic indicators. These programs look at both environmental and socioeconomic aspects and their interaction. Marine protected areas programs, in general, value environmental as well as socioeconomic benefits.

4. Subnational, e.g., state, local, or site-specific coastal management programs, have socioeconomic indicators that describe specific socioeconomic impacts of program components. Within focus areas that are targeted by program components, outputs (process indicators) and impacts including socioeconomic indicators are described (Table 4-13).

Table 4-13 *Summary of Indicators of socioeconomic pressures and conditions*

Theme	Indicator	Level	UN	OECD	WRI	EEA	BP	Other
Coastal population	Percentage of population in coastal areas	National Local Strip	●		●		●	
	Population growth in coastal areas	National Local Strip					●	
Development along shore	Artificialized coastline/total coastline	National Local Strip			●	●	●	
Coastal hazards	Population in coastal high hazards areas	National						●
Fisheries	Annual catch of major marine species	National	●	●	●	●	●	
	Value of catches of major species	National			●		●	
Tourism and recreation	Number of tourists per km of coastline	National Local Strip				●	●	
	Value of tourism and employment in the sector	National Local			●		❍	
	Public areas and access points to beaches	National Local						●
Ports and urban waterfronts	Port economic activity	National						●
	Percentage of (deteriorated) urban waterfronts revitalized	National						●
Other economic sectors	Value and employment in other marine and coastal activities (aquaculture, transport, oil rigs)	National					❍	●
Health	Diseases and infirmities associated to contaminated marine water, fish, and other species	National						●

● Explicitly and currently used
❍ Implicitly or no longer used

In view of the above observations, it is recommended that the development of indicators for ICM be guided by a framework that incorporates environmental as well as socioeconomic indicators. The parsimonious list below has been gleaned from the cases that were reviewed in this study, and constitutes a set of socioeconomic indicators from which programs can draw based on specific needs (Table 4-14).

Table 4-14 *Selected list of socioeconomic indicators*

Focus area	Indicators
Coastal population	• Population density and growth in coastal areas • Population in coastal high hazard areas
Quality of life in the coastal zone	• Unemployment levels (seasonal) • Perceived quality of coastal landscape • Perceived 'quality of life' • Availability of affordable housing • Population age structure
Public information and awareness	• Public awareness of coastal issues • Public awareness of sustainable development
Public access	• Legal availability (legal mechanisms ensuring public access) • Access points (description of types of physical access and areas of access points) • Quality of experience (description of the usability of the public access points and state of surrounding environment)
Service needs and provision	• Education • Health • Welfare • Housing • Water and sanitation • Electricity • Wastewater and stormwater • Roads, railways, airports and harbors • Telecommunications and postal services
Tourism and recreation	• Value of tourism and employment in the tourism sector • Importance of tourism to the economy • Tourist arrivals • Equitable distribution of tourism benefit—leakage of tourism revenue
Fisheries	• Annual catch of major target species • Percentage of household income derived from fishing
Other economic opportunities	• Aquaculture production • Ecotourism • Ocean mining and exploration
Coastal community development	• Environment and land use (description of types of land development in the coastal areas) • Economic (description of economic diversity and positive and negative economic growth) • Social (description of engagement between government and the public) • Public investment and infrastructure (description of alignment between investments and incentives shaping)
Development funding	• Level of finance from multilateral institutions and other international funding institutions
Coastal dependent uses	• Planning and management mechanisms (description of the authority to enact laws and ordinances to protect public health, safety and welfare) • Economic health (measure in physical economics or types of uses and trends in economic development)
Community participation	• Number of people involved in coastal management program activities and extent of participation • Level of awareness of coastal issues • Businesses participating in coastal management activities • Participation in volunteer activities that protect/restore and enhance coastal resources
Coastal hazards	• Population in coastal high hazard areas • Emergency evacuation shelter demand and capacity • Level of awareness of coastal hazards • Number of reported vessel incidents • Land acquired for hazard mitigation
Waterfront revitalization	• Amount of citizen time and cash/in kind donations to coastal management activities • Number of volunteers contributing time to activities associated with waterfront revitalization • Public dollars invested in waterfront communities • Private sector economic investment in waterfront communities • Number of community goals achieved

5. Policy response: governance indicators

5.1 Introduction

Governance performance indicators are designed to measure the performance of the responses to mitigate human pressures on the environment and ameliorate its state as well as improve the socioeconomic conditions of coastal communities. They also measure the progress and quality of the governance process itself, the extent to which a program is addressing and solving the problems that triggered the creation of the program in the first place. These indicators are normally set to measure the performance of program components that address these issues, e.g., public participation.

Since there is no global program that covers broad-based ICM, this chapter will discuss governance indicators of broader use and application as well as specific issue-based global programs that have initiated work in setting indicators such as the World Commission on Protected Areas' *International Marine Protected Area Management Effectiveness Initiative*, the FAO's Indicators for *Sustainable Development of Marine Capture Fisheries,* and the Global International Waters Assessment. At the regional level, the experiences of Europe and Asia through various programs will be discussed while the pioneering national initiatives in indicators setting and application of a few countries such as Australia and the United States will be described. Indicators set to measure the performance of programs or projects or local ICM initiatives follow. Finally, a parsimonious list of indicators has been put together as drawn from the global, regional, national, program/project and local experiences examined.

5.2 Selected examples of governance indicators at the global level

The OECD core set of indicators for development progress

The OECD developed a series of global development goals (OECD 1998), some of which, although of a general scope, are also of relevance to oceans and coasts:

- Reduce extreme poverty by half by 2015;
- Implementation of a national strategy for sustainable development in every country by 2005; so as to
- Reverse trends in the loss of environmental resources by 2015.

These goals capture three major dimensions of sustainable development: socioeconomic development, environmental conservation, and institutional development. For each goal, an indicator has been defined able to capture specific, quantified dimensions:

- *The number of countries with effective processes for sustainable development*, although characterized by the limitation of assessing the actual commitment to sustainable development, can provide insights on specific components of the national strategies referred to localized environmental issues, such as marine quality (e.g., loss of mangrove areas or coral reefs).
- *The land area protected*, for which only an informal goal of 10% for each major ecological region was set in 1991 (IUCN 1991), has a potential for being broken down into subcomponents referred to coastal and marine biodiversity.

- *The incidence of extreme poverty* (e.g., people below $1/day) to be halved between 1990 and 2015, so that the population living in poverty be less than 15% in 2015, could be calculated for coastal regions against total population.

The OECD core set of indicators for environmental performance review

Some of the response indicators defined by OECD for environmental performance review (OECD 1993) are applicable to coastal and marine environments (Table 5-1).

Table 5-1 *OECD indicators for environmental performance review*

Issue	Indicator
Eutrophication	Percentage of population connected to sewage treatment with biological and/or chemical treatment, user charges for wastewater treatment, and market share of phosphate-free detergents
Protection of biodiversity and landscape	Protected areas as a percentage of total area by ecosystem type
Fish resources	Number of fish stocks regulated by quotas and the expenditure for fish stock monitoring
General	Environmental expenditure, public opinion on the environment, and environmental information

The latter indicators could be considered in relation to coastal and marine issues (expenditure for pollution abatement and control for marine environmental quality, public opinion on coastal and marine environmental issues, coastal and marine chapter in the state of the environment report, use of eco-labels for fish products). For all the mentioned indicators longitudinal data are available and can help measure progress towards environmental goals.

The UN indicators for sustainable development

The original set of indicators developed by the UN for sustainable development contained only one response indicator specifically referring to oceans and coasts: the percentage of population served by wastewater treatment plants. This indicator was subsequently incorporated into the freshwater chapter as "wastewater treatment coverage."

International Marine Protected Area Management Effectiveness Initiative (2000-2003)

This project was launched by the IUCN WCPA-Marine and WWF International to improve the management of marine protected areas (MPA) by providing managers, planners and other decision-makers with methods for assessing the effectiveness of MPA sites and of national systems of MPAs. This initiative draws on the accomplishments of the WCPA Management Effectiveness Task Force (METF), especially its recent publication and on-going field testing of generic guidelines for evaluating the management effectiveness of protected areas, which may be applied to MPAs.

A survey of existing goals and objectives of MPAs throughout the world was carried out. These were adapted or expanded to include the full range of possible goals and objectives an MPA may have. A review of journals, manuals, and projects was undertaken to identify indicators that could be used to assess the effectiveness of those MPA goals and objectives. Based on this review, draft matrices of biophysical, socioeconomic and governance indicators linked to MPA goals and objectives were produced. MPA experts were convened in a workshop to review the sets of goals and objectives, and to evaluate these indicators based on a set of criteria. The indicators developed at the workshop will be incorporated into draft guidelines on MPA effectiveness that will be pilot-tested. A sample set of indicators is shown in Table 5-2.

Table 5-2 *The governance dimension of MPA management effectiveness*

Management tools	Management objectives	Indicators of effectiveness
Ensure effectiveness of resource management structures and strategies	Effective and implemented management planning	Existence of a management plan and adoption of plan
	Socially acceptable and clearly defined rules for resource access and use	Understanding of MPA rules and regulations by the community
	Presence of effective and accountable decision-making and management bodies	Existence of an MPA decision-making and management body with a mandate to make management decisions
	Sufficient human and financial resources used efficiently and effectively	
	To recognize and incorporate traditional/local/informal governance in management planning	
	To ensure periodic effective monitoring, evaluation and adaptation of the management plan	
Ensure the Effectiveness of Legal Structures and Strategies for Management	To ensure the existence of adequate legislation	Existence and compatibility of legislation with needs of the MPA management plan
	Ensure compatibility between formal legal arrangements and traditional local arrangement	
	Ensure that national/local legislation incorporates rights and obligations set out in international legal instruments	
	Ensure compatibility of international, national, state and local rights and obligations	
	Ensure enforceability	
Ensure effective and equitable representation and participation of coastal resources stakeholders in management	Representative and effective systems of co-management	Degree of stakeholder participation in management of the MPA
		Level of satisfaction of stakeholders with participation
	Building resource users capacity to participate in co-management	The amount and quality of training provided to resource users to participate in MPA management
	Strengthen and enhance community organizing	The amount and quality of training provided to community organization to participate in MPA management
		Community organization formed and active
Enhance compliance by resources users with management plans	Improved surveillance and monitoring of coastal areas	Available human resources and equipment for surveillance and monitoring
		Clearly defined enforcement procedures
		Number of patrols per time period
	Improve the willingness and acceptance of people to behave in ways that allow for sustainable coastal resources management	Effective education program on compliance for stakeholders
		Regular meeting of MPA staff with stakeholders
	Build the local ability (capacity) to use resources sustainably	Number of people trained in sustainable resource use
	Increase user participation in surveillance, monitoring and enforcement	Number of stakeholders involved in surveillance, monitoring and enforcement
	Adequate applications of law and regulations	
	Ensure transparency and simplicity of, and access to management plan to foster compliance	
Manage coastal resource use conflicts	To reduce conflicts in four levels: 1) within each user group; 2) between user groups; 3) between user groups and community; 4) between community and people outside the community	

Food and Agriculture Organization

In applying frameworks for monitoring sustainable development to fisheries, FAO Fisheries Division has produced technical guidelines offering methodologies for the development of indicators for sustainable development in marine capture fisheries (FAO 1999). The Sustainable Development Reference System (SDRS) approach is proposed as an introductory tool for adoption at national, regional or global levels in fisheries management.

The guidelines have been produced to support the implementation of the Code of Conduct for Responsible Fisheries, in the areas of fisheries management, general principles, fishing operations, integration of fisheries into coastal area management), post-harvest practices and trade, and research. The guidelines aim to provide guidance to decision-makers and policy-makers in marine capture fisheries, fishing companies and fisheries associations, non-governmental organizations with an interest in sustainable development and fisheries, and other groups concerned with fisheries resources.

The guidelines provide general information on the issue of sustainable development of fisheries in order to clarify why a system of indicators is needed to monitor the contribution of fisheries to sustainable development. All dimensions of sustainability (ecological, economic, social, and institutional) are considered as well as the key aspects of the socio-economic environment in which fisheries operate.

The guidelines also provide information on the type of indicators and related reference points needed, recognizing that it is difficult to generalize, and that there is a need to agree on common conventions for the purpose of joint reporting at national, regional and global level.

The guidelines review the various frameworks that have been identified and can be used to organize the indicators and reference points. The guidelines outline the process to be followed, at national or regional level, to establish a Sustainable Development Reference System (SDRS) at sub-national, national, or regional level, focusing on the design of the SDRS, its development (including identification of objectives, selection of indicators and reference points), and its testing and implementation.

The FAO has also recently investigated and provided a review on the use of indicators to assess the performance of regional fishery bodies and their clients in the report: "Indicators to Assess the Performance of Regional Fishery Bodies" from the Second Meeting of FAO and Non-FAO Regional Fishery Bodies or Arrangements in 2001.

Global International Waters Assessment

The Global International Waters Assessment (GIWA) is an initiative of UNEP and is funded under the Global Environment Facility's (GEF) objective of implementing a more comprehensive, ecosystem-based approach to managing international waters and their drainage basins as a means to achieve global environmental benefits. The GIWA project provides objective and strategic guidance for prioritizing GEF's future interventions in the International Waters Focal Area.

GIWA has a global geographic scope with a defined regional focus. The world has been divided into nine major regions, with basic units that include 66 sub-regions defined by their catchment area and associated coastal waters. In each sub-region, local organizers and host institution(s) oversee the GIWA work. The local organizer recruits a team of regional experts, typically from the fields of natural and environmental sciences, sociology, economics, and health sciences, from academia, research institutes, government agencies, and the private sector.

GIWA evaluates various environmental and socioeconomic aspects in sub-regions of the earth, including freshwater and marine systems, but only focuses on those water bodies that have a "transboundary separation of causes and impacts." The five major concerns GIWA focuses on that comprise the areas where environmental degradation impacts human health and welfare, health and the economy include freshwater shortage, pollution, habitat modification, unsustainable use of living resources, and global change. Within these five major concerns GIWA analyzes 22 key issues related to the degradation of international waters.

The GIWA process consists of several stages where a particular methodology developed within the project is used for each stage. The stages are:

1. Assessment of geographical boundaries of the aquatic system and identification of critical concerns in the system (*Scaling* and *scoping*);

2. Detailed analysis of environmental concerns and their impacts on environment and society (*Detailed impact assessment*);
3. Stepwise analysis of the linkages between the identified problems and their underlying root causes (*Causal chain analysis*); and
4. Identification and evaluation of different policy options and potential mitigation actions (*Scenario and policy option analysis*).

For each region, the scoping and scaling exercises will provide information on prioritization of the major concerns and issues within each system; prioritization of the systems according to the severity of perceived impacts; and identification of major concerns within the entire region. Based on local expertise, the GIWA methodology is not uniform among sub-regions.

5.3 Selected examples of governance indicators used at the regional level

Europe

In Europe, the work of the European Topic Centre on Marine and Coastal Environment (ETC/MC) on coastal zone indicators originally focused on pressure and state indicators, with particular attention to eutrophication, heavy metal pollution, overfishing, depletion of groundwater, coastal erosion, climate change, and habitat loss (Izzo 1997). A list of pressure and state indicators was then compiled for a smaller set of issues: eutrophication and saprobiation, heavy metal pollution, fishing, and fragmentation and degradation of habitats (Izzo 1998). At a later stage, response indicators were developed for eutrophication, chemical pollution, and fisheries (Peronaci 1999), with a distinction between policy and environmental responses (or impacts), as shown in Table 5-3.

Table 5-3 *Europe: Policy and environmental response indicators for selected issues*

Issue	Policy response	Environmental response
Eutrophication	The rate of progress in nutrient discharge control measures	The rate of restoration in percentage of the base level of total dissolved oxygen
Chemical pollution	The rate of narrowing the distance between the observed value and an existing target value	The rate of restoration of baseline conditions of the level of metals in seawater The rate of restoration of baseline conditions of the level of organo-halogenated compounds in seawater
Fisheries	The rate of narrowing the distance between the observed spawning stock values and an existing target value	The percentage of the total commercial catch achieved in sustainable conditions

The ETC/MC reported on the state of ICZM in Europe (Peronaci 2000) based on a study conducted by the European Union for Coastal Conservation (EUCC), now The Coastal Union (van Elburg-Velinova, Perez Valverde et al. 1999). The EUCC assessed the progress in ICZM through a series of questions to coastal managers and experts:

1. What is the status of ICZM in your country or region?
2. What is the status of integrated analysis and planning for the coastal zone (land and sea)?
3. What is the status in horizontal coordination?
4. What is the progress in vertical integration of administrative bodies?
5. What is the degree of public participation?

The criteria to determine progress in establishing ICZM are listed in Table 5-4.

Table 5-4 *Criteria for determining progress in ICZM in Europe*

Extent of progress	Criteria
Fully established ICZM	Refers to those regions where ICZM is operational for the whole coastal area. In these cases, the ICZM process includes the following key elements: • Horizontal integration: integrated approach to planning (including environmental and economic issues) • Vertical integration: administrative bodies working together at both a state and a regional level • Public participation: public participation or consultation in cross-sectoral planning.
Partially established ICZM	Regions where ICZM is operational in specific areas of the coast, but not for the region's coast as a whole.
ICZM in progress	Regions where ICZM has reached the stage of active preparation for whole or part of the coast.
Little or no progress	Regions where some environment and spatial planning tools exist, but key elements of ICZM are not occurring. Regions where ICZM is not being considered.

Table 5-5 *Europe: DPISR system applied to coastal zones*

Theme	Driving forces	Pressure	Impact	State	Response
Coastal zones, estuaries, fjords, including wetlands	Spatial development (related to sector and urban development) Extraction/deposition of minerals	Drainage Irrigation Infrastructural works Land reclamation	Land use changes Coastline characteristics	Ecosystem health Human health Morphology/ sediment budget	ICZM

Table 5-6 *Europe: Indicators integrating environmental and socioeconomic considerations*

Issue	Indicator	Type	Timeframe
Coastal water quality	Progress in the implementation of the water framework directive	Descriptive	Short and intermediate
Fisheries and mariculture	Percentage of fisheries reflecting environmental integration	Efficiency	Long-term
	Percentage of mariculture complying to fish farms code of conduct	Efficiency	Long-term
Marine and coastal ecosystems	Sustainable development of regional seas (under development by UNEP)	Total welfare	Intermediate
	Progress in national strategies for ICZM	Efficiency	Intermediate

Results from the survey can only provide qualitative indications of ICM status, while quantitative data should be collected to test these indications. The approach shows that more work is needed at the European level to develop a system of indicators based on tested and demonstrated causal linkages between driving forces, pressures, impacts, state, and responses applicable to the coastal zones.

The methodology suggested appears insufficient and the ETC/MC itself has suggested that the indicator needs to be more quantitative and that the result of the questionnaire is considered to be a 'testing exercise'. Collaboration with regional experts and a more detailed checklist are therefore suggested for development, to improve understanding of the progress made and problems encountered.

In 2000, the Inter-regional Forum Working Group on Indicators further developed the draft system of indicators for the priority themes of eutrophication, hazardous substances, radioactive substances, oil pollution, micro-biological pollution, climate change, waste and dumping, fisheries, introduction of non-indigenous species, nature and biodiversity, and coastal zones/integrated coastal management (Table 5-5) (Peronaci 2001).

Based on this experience, the ETC/MC has developed a tentative DPISR framework for integrating environmental and socioeconomic indicators for three main issues: marine and coastal water quality, fisheries and mariculture, and marine and coastal ecosystems (Peronaci 2001). A sample of the response indicators is given in Table 5-6.

These headline indicators only provide an example of headings for the development of a core set of coastal and marine indicators. They need to be developed further to contribute to a more quantitative assessment of governance performance in ICM.

In 2001, the EEA reviewed the system of European Topic Centres (ETCs) and decided to merge the ETC/MC with the ETC on inland waters (ETC/IW) as a ETC on water (ETC/WTR), located in the UK. The ETC/WTR has recently delivered its first draft report on the Core Set of Indicators which will be used to produce the indicator-based report Water in Europe in June 2002. Among the indicators, 9 cover the Driving Forces; 11 the Pressures; 22 the State; 7 the Impact and 6 the Responses. With the onset of the Water Framework Directive the Core Set will rise to around 81 indicators by 2005 or later.

Assessment of Integrated Coastal Area Management Initiatives in the Mediterranean: Experiences from METAP and MAP (1988-1996)

This assessment was carried out to help guide the next round of investments in integrated coastal area management proposed under the Mediterranean Environmental Technical Assistance Program (1996-1999) and the Mediterranean Action Plan (up to 2000) by undertaking a selective review of ICAM initiatives in the region between 1988 and 1996 (METAP 1998). The main objectives of the evaluation are to:

- Identify those ICAM initiatives, which have been successful in meeting project objectives;
- Identify constraints to establishing or advancing ICAM initiatives;
- Assess at the regional level, the contribution of individual initiatives and the larger programmes of which they are a part (particularly METAP and MAP);
- Outline the lessons learned from these initiatives which may be applied in the region;
- Propose recommendations for replicating successes on a larger scale;
- Propose policy level recommendations regarding the place and importance of ICAM to the parties of the Barcelona Convention; and
- Inform METAP and MAP and sponsors of other pending initiatives in the region of the results of the study.

The evaluation process involved the identification of 30 programmes, plans and projects that qualified as coastal management projects. From this set, nine case studies were selected for in-depth evaluation using a framework consisting of a number of key dimensions (performance, integration, and sustainability). Performance dimension involved 1) an analysis of the successes and weaknesses of an intervention; and 2) distinguishing whether factors are the result of the intervention itself or whether they originate in the wider context where the intervention is carried out, i.e., externalities. The integrated dimension refers to the level of horizontal or vertical linkages or interdependencies achieved among sectors, plans or administrative levels in the area concerned, distinguishing between sectoral integration, the integration of environmental component in the socioeconomic context, the governance integration, and the level of participation. The sustainability dimension deals with the follow-up prospects of the initiative including financial, institutional and political aspects of sustainability.

Among the lessons learned in this evaluation is that an evaluation mechanism has to be built in right from the beginning, while programme monitoring must be linked to evaluation throughout project implementation.

5.4 Selected examples of governance indicators used at the national level

Australia

To meet its international obligations under Agenda 21 and the OECD environmental performance reviews, Australia began with the *National Strategy for Ecologically Sustainable Development*, supported by the Commonwealth State of the Environment Reporting system. In September 1996, the Commonwealth Environmental Minister also released *Australia: State of the Environment 1996,* which was the first comprehensive and independent assessment of this country's environment. This report cited Australia's lack of "the data, the analytical tools or the scientific understanding" needed to determine whether it was on a sustainable

track. Australia's 1998 *State of the Environment Environmental Indicator Report* discussed the next step necessary for improved reporting of the system: the development of a national set of indicators that would facilitate the tracking of environmental conditions and the anthropogenic forces on them. Of the seven major themes upon which this 1998 environmental report was based, that of "Estuaries and the Sea" encompasses 61 ocean and coastal management indicators for use at the national level.

Approach

The 61 ocean and coastal indicators may be classified as follows:

- 3 pertaining to Species or Taxa;
- 9 to Habitat Extent;
- 17 to Habitat Quality;
- 6 to Renewable Products;
- 2 to Non-renewable Resources;
- 5 to Sediment or Water Quality;
- 17 to Integrated Management; and
- 2 to Ecosystem-level Processes.

The selection of this set of indicators involved much scrutiny. Australia chose both structural and functional environmental indicators. However, the overall indicator set consisted of more structural indicators, due to their tendency to be more sensitive and thus, provide earlier notice of significant environmental change. Australia also emphasized the importance of choosing the appropriate spatial and temporal parameters within which to measure each indicator. These proper measurement scales as well as the inclusion of uncertainty estimates in the reported data are considered crucial for accurate and credible State of the Environment (SoE) reporting. Also, in order for the data collected at the local level to be considered relevant for reporting at the international level, Australia deemed it necessary to compile data summaries at each level of government. For example, after collecting the data at the local level, it could be reported to the state and territory governments, which would synthesize it and report the findings to the Commonwealth, which could further delineate national trends and summarize the findings for reporting internationally.

Australia has recognized the need to promote integrated coastal and ocean management by working toward a more ecosystem-management approach when selecting indicators. In order to adequately report on an ecosystem's true condition and to better meet the goals of integrated management, it has selected five core attributes to direct the development of environmental indicators: stability, diversity, yields, resilience, and productivity. Each of the indicators selected pertained to one or more of these attributes as well as to the OECD PSR model. Furthermore, the indicators were selected after meeting the following criteria, selected from an extensive list: scientific credibility, cost-effectiveness, measurability, national scope, and ability to provide an early warning of future problems.

The majority of the Australian indicators measure environmental changes, while 17 measure integrated governmental and/or socioeconomic factors. These integrated management indicators help to measure the progress made in shifting from the sector-by-sector and resource-by-resource approaches toward a more holistic, integrated management of ocean and coastal resources. The indicators, which were defined and described in terms of unit, method of measurement, and data sources are shown in Table 5-7.

Table 5-7 *Integrated management indicators for Australia*

Indicator/ Type of indicator	Definition	Unit	Methodology
1. Beach Stabilization/R	Cost and nature of beach replenishment and stabilization projects on the open coast, in estuaries, and in lagoons and bays.	• Number of hard stabilization projects/ nourishment programs • Costs of these programs • Data recorded per km of coastline	Hard stabilization projects include, but are not limited to, the construction of groins, seawalls, and ramparts. Engineering costs and effort are also accounted for by assessing the number of renourishment episodes.
2. Catchment Development/P	Nature and types of land usages in the coastal stream and river runoff areas for lagoons, bays, and estuaries.	• Under development as part of the Land theme	Under development, but based on the rationale that changes in land use patterns will be documented by this indicator. The frequency, duration, and components of river and stream runoff have significant control over sediment and water quality conditions in estuaries, lagoons, and bays.
3. Catchment Management Programs/R	Nature and number of catchment management programs regarding coastal streams and rivers.	• Under development as part of the Inland Waters theme.	Under development, but based on the same rationale as that given for the Catchment Development indicator. This indicator will be designed to measure changes in catchment management program implementation efforts.
4. Coastal Care Community Groups/R	Number of allied and Coastcare groups, the costs of programs administered (in each estuary, IMCRA subregion and Marine Region) and the member numbers in each group.	• Number of allied and Coastcare groups • Number of people involved • Annual dollar costs	The extent of local citizens' participation in these groups is a direct measure of their concern and knowledge of coastal issues in their community.
5. Coastal Discharges/P	Number and locations of certified point-source discharges into lagoons, bays, estuaries, and coastal waters. It also documents the volume and type of discharged materials.	• Type of material discharged • Location of outfalls • Number of outfalls • Estimates of annual volumes/loads of discharged materials (units not specified)	The discharges to be assessed include those from industrial and sewage outfalls, as well as those from urban stormwater drains.
6. Coastal Population/P	Numbers and locations of people in coastal towns, cities, and agricultural regions. It also documents shifts in populations.	• Under development as part of the Human Settlements theme	Under development, but based on the rationale that the amount of marine and estuarine degradation frequently is directly proportional to the magnitude of the local resident population.
7. Coastal Tourism/P	Number of tourists and the duration of their stay in specific coastal regions.	• Number of local (day) and extended (overnight) trips within each estuary, IMCRA subregion, and Marine Region	The number of day and overnight trips accounts for the tourists' duration of stay.
8. Fishing Effects on Non-target Biodiversity/R	Number of fisheries management plans with effective indicators for monitoring the levels of impacts on non-target organisms, as well as the amount of reduction in those impacts (number of indicators will also be measured)/	• Number of fisheries management plans (FMPs) • Number of indicators within the plans	The FMP indicators may include direct and indirect measures of impacts on non-target biodiversity. For example, an inventory of epibenthic fauna in trawling grounds may provide a direct measure, while trawl bycatch amounts may provide an indirect measure.

Table 5-7 *Europe: DPISR system applied to coastal zones*

Indicator/ Type of indicator	Definition	Unit	Methodology
9. Great Barrier Reef Management/R	Government and tourism-derived funds allocated to management of the Great Barrier Reef (GBR) every year.	• Annual dollar amounts	Tracking of funds from government sources to the Great Barrier Reef Marine Park Authority (GBRMPA) and the Queensland Department of Environment for the management of the GBR, and to scientific institutions for research on the GBR accounts for their allocation on a yearly basis.
10. Integration of Management/R	Number of regions under an integrated and effective ecosystem management framework Environmental performance indicators within those frameworks, which measure ecosystem attributes under the jurisdiction of the local, state, and federal governments as well as those related to private sector activities.	• Number of regions	This indicator assumes that ocean and coastal management will fall within an overarching national management framework, while proceeding on a hierarchical and regional basis. The indicators and sectoral objectives will be evaluated based on their relevance to their respective regions' and subregions' ecosystems.
11. Marine Network Participation/R	Participation in the Marine and Coastal Community Network (MCCN).	• Number on mailing list by IMCRA subregion and Marine Region, documented consistently each year	Monitoring mailing list numbers will show the changes in the public awareness of, interest in, and support for coastal issues over time.
12. Marine Protected Areas/R	Number, classification, and extent of marine protected areas (MPAs), RAMSAR sites, and World Heritage Areas.	• Number of sites • Area in square km • Number of implemented management plans for MPAs that include representative biodiversity factors and consistent monitoring	The MPAs, RAMSAR sites, and World Heritage sites must be formally recognized by Commonwealth or State legislation. Within each MPA, the area of each IUCN management objective sub-category and category will be measured.
13. Commonwealth Government Marine Management/R	Annual Commonwealth Government expenditures for marine and coastal management programs at national, regional, and local levels.	• Annual dollar amounts	Funds allocated to environment, resource, and conservation sectors will be measured. The total funds include money raised by governing authorities through levies and other charges. This indicator will monitor the Commonwealth Government's monetary responses to changing issues in coastal management.
14. Ship Visits/P	Occurrence of ship visits to Australia by port of origin, nature of cargo, and type of vessel.	• Number of ships • Type of cargo (exported or imported)	Broad classes of vessels and cargo types will be used to classify the ships and cargo carried. Every Australian port will be evaluated for indicator-relevant data.
15. Shipping Accidents/P	Occurrence of shipping accidents in Australia's waters. Nature of the cargo carried, the materials lost, environmental damage estimates, and the number of ships inspected for safety, with inspection problems noted.	• Number of shipping accidents • Number of ships annually inspected for compliance with safety standards • Number and nature of detected problems during inspections	The pressure imposed by marine transportation will be assessed by tracking the location, number, and nature of shipping accidents in and near ports, harbors, and shipping lanes. Broad classes of vessels and cargo types will be used to classify the ships and cargo carried. Also, broad classes will be used to classify the nature of the shipping accidents. Estimates will be made for resulting environmental damage and for materials lost to the environment.
16. State Government Marine Management/R	Annual State and Northern Territory expenditures for marine and coastal management programs at regional and local levels.	• Annual dollar amounts	Funds allocated to environment, resource, and conservation sectors will be measured. The total funds include money raised by governing authorities through levies and other charges. This indicator will monitor the State-level governments' monetary responses to changing issues in coastal management.
17. World Heritage Area Tourism/P	Number of tourists visiting two marine World Heritage sites (Shark Bay and the Great Barrier Reef). Estimates of annual tourism fees, levies, and direct charges paid by tourists at the two sites.	• Number of tourists • Annual dollar amounts	Under development, but designed to measure tourism pressure on Shark Bay and the Great Barrier Reef.

Problems and Successes

The implementation of this system of indicators has been constrained by significant gaps in knowledge at various levels, including: a) distributional data on species and assemblages; b) lack of available statistical tools relevant to State of the Environment uses; c) lack of qualified taxonomists; and d) lack of synthesis of existing biological data and information. Nevertheless, the following observations indicate the usefulness of these indicators:

- The integrated management indicators quantitatively and effectively show the level of management effort currently underway with regard to governmental funding for coastal and marine projects, the number of marine protected areas, or the number of management plans;
- These indicators also quantitatively and effectively show the level of ocean and coastal management effort with regard to fishing/aquaculture, development, and population pressures; and
- The complete set of Australian indicators has been noted as a good example of a formal reporting system that uses tiers of indicators to create a national snapshot of conditions. These indicators, found at all levels of government, are more detailed at the local level and eventually feed into the international level after summarization and synthesis.

United States of America

The Coastal Zone Management Act (CZMA) in 1972 is the first piece of legislation of its kind in the United States for improved coastal management. It provided for the development and implementation of 33 state coastal management programs. After 30 years of implementing federally funded coastal management programs with little to no recorded performance measurement, the U.S. Congress issued a draft reauthorization bill that requires the National Oceanic and Atmospheric Administration (NOAA) to develop a national system of indicators and performance evaluation within approximately three years of enactment. In the initial phase of this effort, approximately one year after the bill's passage, a national system of indicators will be produced. In the second phase, the adequacy of coastal and marine monitoring will be assessed. Recommendations will be made during this time on how to better organize and assemble the information obtained for performance evaluation. The indicators system will be constructed in the final phase.

Three independent studies have been conducted on the status and development of the national indicator system on performance measurement. The findings for each study were presented and draft reports distributed at the annual Ocean and Coastal Resource Management (OCRM) Program Managers' meeting held in March of 2002. This gathering proved especially valuable in that it provided a common forum for debate, idea-sharing, and information-gathering for state, NOAA, and National Estuarine Research Reserve System (NERRS) managers. The focus of each study is presented below.

NERRS Study

Interviews were conducted with representatives from the 25 NERRS sites, one national wildlife refuge, and one national estuary program. A common set of questions was used in each interview to collect baseline data on the use of performance indicators and measures at each site. This information will provide the foundation for the development of appropriate system-wide reporting guidelines and reporting measures.

National Ocean Service (NOS) Study on Indicator Use in Coastal States

The goal of this project was to assess the use of indicators by 5 (out of 33) different state coastal management programs (California, Delaware, Mississippi, New Jersey, and Wisconsin). The study investigated whether or not these states were measuring their coastal management program's performance through a series of workshops to determine the current use of indicators, and measures that might make sense in the future. The project focused on five goals included in the CZMA: wetland protection and restoration, natural hazard loss reduction, coastal access, urban waterfront revitalization, and public involvement in decision making.

In the five states examined, there are no standardized or commonly accepted methods for measuring the effectiveness of coastal programs. It is expected that the results of this study will be used in the development of a common set of indicators for use across states and territories. The workshop participants identified 187 potential measures across the five CZMA goals, which were narrowed down into a set of most frequently identified indicators as shown in Table 5-8.

Table 5-8 *Indicators identified most frequently at the NOS workshops*

Goals	Indicators
Coastal Wetlands	• Wetlands acreage • Wetlands health • Permitted wetland alteration • Rare wetland
Coastal Hazards	• Structure at risk • Damages due to hazard events • Vulnerability
Public Access	• Beach closures • Acquisition • Miles/points/acres • User perceptions
Ports/Urban Waterfront Revitalization	• Commerce handled • Planning assistance • Change in space utilization • Assessed value of property
Public Participation	• Public meetings • Grants to sponsors • Public perception • Integrated efforts • Web hits

Source: NOAA/NOS 2002

Heinz Center Study

This study presented a framework for achieving a national system of indicators. It delineated six major focus areas: Public Access; Coastal Habitats & Biodiversity; Coastal Community Development; Coastal Hazards; Coastal Dependent Uses; and Coastal Water Quality. Within these focus areas, dimensions (sub-areas) were established and example indicators provided, as shown in Table 5-9.

According to the Heinz Center, however, it is beyond the scope of the federal government to determine indicators. Thus, this framework shows how each state must recognize the over-arching federal goals for performance measurement while, at the same time, determining its specific management objectives under those goals and the necessary indicators they would like to use to measure them.

Table 5-9 *Heinz Center's Coastal Management Performance Measures and Indicators*

Focus area	Outcome statement	Subgoals	Dimensions of focus area
Public Access	Change in amount or quality of access opportunities for recreational purposes available to the public	• Provide and/or enhance public access to coastal resources that does not damage or degrade these resources • Promote and enhance community awareness of public access points	• Legal availability (legal mechanisms ensuring public access) • Area by type (description of lands that might be accessible) • Access points (description of types of physical access and areas of access points) • Quality of experience (description of the usability of the public access points and state of surrounding environment)
Coastal Habitats/ Biodiversity	Changes in coastal habitat, viability and integrity of natural communities	• Maintain and restore healthy coastal ecosystems • Protect, restore, or enhance coastal habitats • Maintain or restore natural rates of primary production • Maintain natural hydrology and ranges of salinity • Maintain natural hydrology and ranges of salinity • Maintain diverse indigenous populations of plants and animals at viable, ecologically balanced levels	• Size (area or abundance of populations) • Condition (description of the composition, structure and biotic interactions of populations) • Landscape context (description of dominant environmental regimes influencing composition of populations and the connectivity between populations and ecosystems)
Coastal Community Development	Development and redevelopment of coastal communities that reflects the communities vision for sustainable growth, ensuring a healthy ecosystem and preservation of cultural values	• Well-planned growth based on the combined needs of the ecosystem, the economy and community culture • Public involvement in both decision-making and delivery of community-based goals • Revitalization, re-use and redevelopment of coastal resources	• Environment and land use (description of types of land development in the coastal areas) • Economic (description of economic diversity and positive and negative economic growth) • Social (description of engagement between government and the public) • Public investment and infrastructure (description of alignment between investments and incentives shaping growth and community values)
Coastal Hazards	Changes in the amount of life and property vulnerable to coastal hazards	• Reduce economic losses and loss of life due to hazard events • Promote and enhance public awareness of coastal hazards and mitigation measures • Encourage state and local implementation of land use and zoning measures that decrease vulnerability to hazards in coastal areas	• Land use and transportation planning (description of coastal area in order to avoid inappropriate development in hazardous areas) • Mitigation, response and recovery (of property owners and government to hazards) • Vulnerability (of property to coastal hazards
Coastal Water Quality	Changes in coastal water quality	• Protect and improve coastal water quality • Reduce the delivery of pollutants (derived from land, the sediment, the atmosphere, or the ocean) • Protect and restore natural resources	• Pollutant inputs (description of changes in the sources and amounts of pollutants loaded to coastal systems) • Water quality conditions (includes direct and indirect measures of water quality) • Ecosystem effects (description of consequences of changes in water quality in terms of coastal resources)
Coastal Dependent Uses	Changes in opportunities for coastal-dependent economic development	• Promote policies that encourage levels of coastal-dependent economic growth consistent with the protection of natural resources, existing uses and the quality of coastal waters • Promote coordination and simplification of procedures in order to ensure expedited government decision-making for the management of coastal resources and siting of major coastal-dependent uses • Ensure the safety and security of coastal development • Incorporate national siting and resource needs in the development of state and local plans and development actions	• Planning and management mechanisms (description of the authority to enact laws and ordinances to protect public health, safety and welfare) • Economic health (measure in physical economics or types of uses and trends in economic development)

Successes and Constraints

The initiative has met with some constraints based on reports of coastal managers, including:

- Lack of funding;
- Fear of unfavorable comparisons between state coastal management programs;
- Political boundaries;
- Varying interpretations of a standardized indicator set;
- Difficulty and/or inability to measure short-term initiatives and major accomplishments;
- State management programs' fear of being held responsible for outcomes beyond their control;
- Difficulty in matching states' objectives with those at the federal level;
- Environmental, economic, political, and technological differences between the states;
- Lack of time; and
- NERRS sites engaged in performance-based management lack necessary training.

Many skeptical state and federal coastal management representatives, however, have begun to discover the potential opportunities and benefits of creating a standardized system of indicators in the United States, including: better planning and resource allocation; improved communication; environmental protection; better accommodation of growth; adaptive management; facilitation of planned or ongoing efforts; and healthier coastal communities. Recognition of these intrinsic benefits of developing national indicators creates incentives for participants at all levels to join in this difficult process.

More than half of the NERRS sites are now taking part in performance-based management. Furthermore, NERR sites and NOAA have successfully worked together toward implementing national initiatives. These initiatives provide information that is useful for NERRS site-level as well as national needs. See Box 5-1 for lessons learned.

Box 5-1 U.S. lessons learned fro the NERRS Sites

Lessons Learned

A number of lessons learned drawn from the initiative so far include:

- NOAA, NERRS site managers, and state partners must work together to create indicators that apply to the objectives of all three entities.
- The OECD PSR model effectively incorporates ecological, management, and socioeconomic indicators into a comprehensive overview of change at NERRS sites.
- It is important to involve the user in developing performance measures and indicators to ensure the measures pertain to their needs.
- In order for performance measures to be most useful to NERRS sites, they must be generated locally.
- One of the important first steps in developing a national system of indicators and measures is the establishment and use of a common terminology.

Recommendations

- NOAA should consider an over-arching initiative for all NERRS sites that offers technical and financial resources. It should also provide insights into their management plan revisions by encouraging strategic planning and performance-based management.
- Significant expertise on performance measurement exists among NERR site, state coastal zone managers, and NOAA managers. This experience should be shared across each sector and between all levels.
- Due to the fact that the most useful performance measures to coastal communities and sites are created locally, it is recommended that local-level performance measures continue to fit specific local needs. Such tailoring will better ensure that the communities and sites maintain usefulness, relevance, and consistency with reporting requirements. These performance measures should be adapted to address the needs of the national system at the same time.
- Feedback is requested from the researchers who conducted the NERRS, NOS, and Heinz Center studies. It is strongly suggested that such input be provided.
- The final system of national indicators should be incorporated into the OECD P-S-R framework. It is recommended that consideration of this objective be considered in the earliest phase of the indicator selection process, in order to better ensure this end.
- Coastal program managers have recognized the urgency for information-sharing among the states and have recommended the establishment of a national website for this purpose. Every three to five years, the findings and information on this site could be converted into a report.

Few coastal states with indicators have given much attention to socioeconomic and governmental indicators and instead have focused more on environmental indicators. It is recommended that regional workshops be held to train program managers on the development of these underrepresented measures.

5.5 Selected examples of governance indicators at the subnational/state level

Nova Scotia, Canada

Until recently, Canada's approach to assessing the success of environmental efforts has focused on environmental indicators to measure the condition or state of the environment, not the performance of management or connections between management and marine environmental quality.

Approach

Criticism has arisen within Canada, calling for a new approach in selecting indicators for measuring trends in sustainable use and environmental quality. The Nova Scotia *Genuine Progress Index (GPI) Fisheries and Marine Environment Accounts* has proposed a new framework, developed locally, that can be applied nationally. The indicators proposed by this framework do not only involve the environment and socioeconomic progress, but also the welfare of coastal communities, and the "institutional integrity of fishery and ocean management" (GPI 2002). A sample of the new governance indicators is shown in Table 5-10.

Table 5-10 *GPI governmental indicators*

Dimension	Indicator
Adequacy of institutional resources	Total expenditures Expenditure distribution by category
Acceptability of governmental expenditures	Expenditures as a proportion of landed value

Box 5-2 Genuine Progress Index lessons learned

Lessons Learned

- Canada recognizes the importance of information-sharing, exemplified in its Oceans Program Tracking Activity (OPAT) website, which provides details on the number and status of the DFO's integrated management plans and serves as a forum for information exchange.
- In choosing its indicators, Canada has tended to view fisheries apart from other ocean uses. Even in its choices of sustainable use indicators, by choosing to measure changes in specific species, or sets of species, it has developed a fragmented, not an integrated, approach.
- The Nova Scotia GPI analysis has recognized the importance of designing indicators with a more integrated view, taking into account the complicated interactions among species, within marine ecosystems, and among the humans relying on those ecosystems.
- The GPI analysis has learned the importance of using multiple indicators, analyzing each one separately, and understanding the individual implications, instead of simply adding up the results.
- The GPI analysis recognizes the importance of informing the general public and policy makers about the status of fish stocks and other natural resources. Such a practice will provide warning signs early enough in advance to galvanize action, if needed, and prevent the collapse of an important resource.
- The GPI analysis recognizes the need for new databases and improved data sources for measuring the well-being of communities as well as the performance of current management.

Recommendations

The addition of governance indicators into the GPI Fisheries and Marine Environment Accounts system is truly significant. Incorporating these indicators into the national framework would better inform program managers, policy analysts, and decision-makers about current administrative, organizational, and financial adequacy. They would also provide insight into enforceability of resource regulations and hold organizations more accountable for their management actions. It is recommended that Canada adopt this more cohesive GPI model.

GPI Atlantic seeks feedback on its preliminary indicator set. It is recommended that input would be given from a variety of sources to enhance the chosen methodologies, data sources, and indicator choices.

Historical and current gaps in data and the need for new data sources pose a major challenge for Canada. It is recommended that the approach to improving data availability involve actors from academia, the governmental sector, and NGOs to the ocean and coastal user level. Also, integrating these data sets, as needed, is fundamental for successful indicator measures.

Florida, United States of America

Out of the 33 coastal states in the US with CZMA-approved programs, Florida has emerged as a leader in performance indicators and measurement. The Florida Coastal Management Program issued its first collection of approximately 100 indicators on coastal issues in 1995 Florida Assessment of Coastal Trends (FACT). Some of the primary weaknesses identified in this report related to insufficient data for indicators. In 1997, consequently, the second edition of FACT modified the original indicators list and reflected improved data sources. Both of the 1995 and 1997 FACT indicator sets documented important ecological, economic, and cultural conditions. However, they focused more on processes and conditions, without showing the connections between these conditions and management efforts. The most current publication of FACT (2000) catalogues and describes ecological, socioeconomic, and governmental indicators by taking a more performance-based measurement approach.

Approach

FACT 2000 targets these aspects of coastal resource management: coastal hazards; coastal access; community involvement; economic development; habitat and biodiversity; land acquisition; land use; outreach and education; tourism and recreation; and water quality. These categories were simplified, with 36 indicators identified within them. These ocean and coastal indicators may be classified as follows:

- 3 pertaining to Biodiversity and Natural Areas
- 7 to Coastal Access
- 6 to Coastal Hazards
- 7 to Community Stewardship
- 8 to Marine and Estuarine Health, and
- 5 to Waterfront Revitalization

In selecting the FACT 2000 indicators, consideration was given to how well an indicator might address the goals of a particular focus area. Other important criteria used in selecting these indicators include quality of data (reliability, validity, and availability), the potential for trend analysis, and appropriateness of scale. Selected performance indicators pertaining to Florida's ocean and coastal management are described in Table 5-11.

Table 5-11 *Indicators for six focus areas in the Florida Coastal Management Program*

Focus Area	Indicator
Biodiversity and Natural Areas	• Conservation Land Management • Florida State Park Management
Coastal Access	• Beach Length and Access Points • Coastal Access adequacy • Coastal Access land acquisition • Land Acquisition FCMP Grants
Coastal Hazards	• Emergency Evacuation • Retrofitted Buildings • Community Rating System
Community Stewardship	• Volunteer activities • FCMP grants
Marine and Estuarine Health	• Manatee status
Waterfront Revitalization	• Community goals

Source: FCMP and FDCA 2000

The Florida Coastal Management Program obtained the majority of data for these indicators from coastal resource management agencies at federal and state levels. In addition, a random phone survey of over 1,000 state residents was conducted for data in the Coastal Access, Coastal Stewardship, and Coastal Hazards focus areas.

Some of the above indicators directly report the community's opinion on the success of a particular management program. For example, the "coastal access adequacy" indicator within the Coastal Access focus area gives Florida's coastal program managers feedback on their success in providing coastal access to Florida residents and tourists and on areas for improvement. Other indicators, such as the indicator on "manatee status" within the Marine and Estuarine Health focus area, shows how effective laws and associated regulations are in protecting manatees. A number of the other indicators, furthermore, allow for performance measurement by looking at the revenues drawn from managed conservation lands and state parks. See Box 5-3 for lessons learned from the FCMP.

Box 5-3 Lessons learned from FMCP

Lessons Learned

- Florida's improved set of indicators in FACT 2000 (soon to be superceded by FACT 2002) promote more "results-based management" by linking yearly budget allocations with measurable coastal program outcomes.
- The Florida Coastal Management Program (FCMP) indicators quantitatively and effectively show the level of management effort currently underway with regard to governmental funding for programs dealing with waterfront revitalization, coastal access, community stewardship, ecosystem health, tourism, and biodiversity.
- These indicators also quantitatively and effectively show the level of coastal management effort regarding estuarine health, coastal hazards, conservation lands, and vessel groundings/sinkings.
- Florida's indicators not only measure the FCMP efforts but also public perceptions of these efforts, the value placed by the public on different coastal issues, the public's awareness level of coastal issues, and ultimately, the public's efforts, through monetary and personal service contributions, to better manage Florida's coastal resources.
- The FCMP has received and will continue to receive valuable feedback (both positive and negative) from residents across the state on management progress and ways to improve their management efforts.

Constraints

- Gaps in data for water quality, manatee populations, and business expenditures for harbor revitalization;
- Failure of businesses to comply and supply needed data;
- Lack of and/or poor quality of state and local agency databases; and
- Difficulty in measuring the performance of newly instituted programs, namely the *Waterfronts Florida* program for harbor revitalization.

Lessons for Improvement

Florida recognized the need for further research to collect better biodiversity and habitat data (more accurate data needed for incorporation into economic models for better projections). This improved information will promote more accurate and successful State of the Environment reporting. Additionally, the FCMP has learned the importance of gathering adequate indicator information for baseline data as soon as new coastal programs start as well as the necessity for using consistent data-collection methodologies across sectors and at varying governmental levels.

While Florida's extensive set of 35 indicators for measuring coastal resource management can provide adequate data for effective performance evaluation, it is recommended that they also be adapted to provide adequate data for outcome evaluation. This additional step can be taken by linking the changes in management efforts with their expected effects on the coastal resources.

5.6 Selected examples of governance indicators at the local level

International Council for Local Environmental Initiatives (ICLEI)

"Local Agenda 21" (Chapter 28 of Agenda 21) is essentially a process towards sustainable development of a town, municipality or a city because many problems and solutions of the Agenda 21 relate to the local level. LA21 implements the action points of the global Agenda 21 at the local level and involves environmental, as well as social and economic aspects. LA21 also seeks to reinforce the role of different groups in the local society and stimulates the development and consolidation of partnerships between these groups. ICLEI has been organizing so that LA21 will be used to advance sustainable development.

There are three important components of LA21:

1. Dialogue: between local government and the different organizations in local society;
2. Environmental education: to improve consciousness, commitment, and behavior of the local actors with the environment and sustainable development; and
3. International cooperation between local communities. In order to achieve a worldwide current towards sustainable local development, interchange and solidarity at global level have to be reinforced.

Communities are provided with an introductory guide on the planning elements, methods, and tools being used by local governments to implement Agenda 21 at the community level (ICLEI. 1996. By drawing general conclusions from the work that is already underway at the local level,

it recommends a general sustainable development planning approach as outlined below:

1. Partnerships: Establish an organisational structure for planning by service providers and users. Establish a shared community vision.
2. Community-based issue analysis: Identify the issues that must be addressed to achieve the community vision. Do detailed assessments of priority problems and issues.
3. Action planning: Agree on action goals, set targets and triggers, and create strategies and commitments to achieve these targets. Formalise into action plan.
4. Implementation and monitoring: Create partnerships structures for implementation and internal management systems for municipal compliance. Monitor activities and changes in services.
5. Evaluation and feedback: Do periodic performance evaluations using target-based indicators. Provide results to service providers and users. Repeat issue analysis and/or action planning processes at specified trigger thresholds. Celebrate and reward achievement.

Approach to indicator setting

Based on available information, it appears that the LA21 approach is issue-based. Target-based indicators are based on objectives that address priority issues that are set during action planning. Target-based indicators are used to provide information about the project's progress to service providers and users as well as provide basis for rewards.

The indicators gleaned from the same sources are shown in Table 5-12.

Table 5-12 *Indicators for local Agenda 21*

Area	Indicator
Socioeconomic	• Upgrading of unserviced settlements • Managing the economy and integrating petty trading
Institutional/Governance	• Incorporation of ICM in Local Agenda 21 • Extent of participation of local stakeholders • Commitment of LGUs and communities to improve and extend services

Strengths and Weaknesses of the Approach

Based on the cases that were examined (Japan and Tanzania), it seems that projects are strong in planning but weak in monitoring and evaluation. Moreover, no information can be derived on the usefulness of project indicators.

The Philippines' Guidelines for Annual Monitoring and Evaluation of Municipal/City Coastal Resource Management Plans and Programs for Certification

In the Philippines, the primary mandate to manage coastal resources was devolved to the local government level with the passage of the 1991 Local Government Code and 1998 Fisheries Code. Coastal municipalities and cities were given jurisdiction over coastal resources and municipal waters and the responsibility for implementing coastal resource management in collaboration with the provincial government, national government agencies, NGOs, and academic institutions. Recognition of the need for monitoring and evaluation of municipal and city coastal resource management programs came about with the need to sustain management interventions initiated by various coastal management programs. Thus, the development of guidelines for monitoring and evaluation of these programs (see Courtney et al. 2001) was initiated by the Coastal Resource Management Program, a USAID-funded program that targeted the promotion of municipal, city and provincial coastal management initiatives in various learning sites in the Philippines.

Approach

The monitoring and evaluation framework is anchored on a five-phase coastal management process which follows the generalized coastal resources management model. Municipal and city monitoring programs are to be developed to track both process and results indicators. Process indicators are used to monitor the governance aspects of coastal management plan implementation including how and when planned activities are progressing, how social processes are proceeding, and whether there is adequate public participation by all stakeholders in the management process. Results indicators are used to monitor the outcomes or impacts of these processes on behavior change and socio-environmental conditions. The framework for setting indicators is patterned after the Input-Output-Outcome-Impact model.

The following is an illustrative set of impact indicators for coastal management programs:

- Municipal fish catch per unit effort (kilograms/fisher/day);
- Living coral cover and fish abundance inside and outside marine protected areas (%living coral cover, number of fish/500 square meter);
- Mangrove area under effective management (hectares planted and managed);
- Upland forest area under effective management (hectares planted and managed);
- Solid waste management system effective (volume of solid waste recycled/disposed);
- Household income in coastal barangays (income/family);
- Frequency of coastal management-related violations (daily, weekly, monthly); and
- Level of stakeholder support for coastal management plans and programs (percentage of stakeholders with knowledge of and supporting coastal management best practices) (Courtney et al. 2001).

Monitoring and evaluation activities are guided by a set of benchmarks that describe the level of performance of the local government unit in delivering coastal management services for beginning, intermediate, and advanced levels of coastal management implementation. Illustrative monitoring and evaluation activities, as well as guidance on planning of monitoring and evaluation activities and reporting of results are also provided in the guidelines.

The guidelines also feature the role of certification in benchmarking local government performance in coastal management. A Coastal Resource Management Certification System has been developed and tested in response to interest expressed by local government officials. This certification program is patterned after international standards for organizational and environmental management systems (ISO 9000 and ISO 14000). It is a voluntary process in which an independent third party provides a written certificate showing that a product, method or service satisfies certain predetermined requirements or criteria. Among the benefits of certification is the provision of a framework for prioritizing investments of local and national government and foreign donors to CRM-certified municipalities and cities (Courtney et al. 2001).

Field Testing

The guidelines and coastal management certification system were field-tested in over 30 municipalities and cities. Necessary revisions based on comments and feedback received from the field have been incorporated in the current version of the guidelines which will undergo further periodic review and revision as needed based on subsequent implementation experiences.

5.7 Summary and selected list of governance indicators

The use of governance performance indicators for ICM is still in its infancy. Some efforts have been carried out to monitor progress of ICM at the global (OECD), regional (EU), and program level (most notably by the Coastal Resources Center and PEMSEA), see Table 5-13 for a summary of governance indicators. Difficulties are apparent particularly with respect to tying ICM efforts to on-the-ground changes and the attribution of effects to ICM programs remains an open issue.

At the program and project level, the input-output-outcome-impact framework developed by the World Bank, as well as the outcome evaluation model, provide an important framework. This has to be accompanied by the setting of specific goals and baselines for ICM programs to monitor their effects. On these lines, attempts are being made, for example in the U.S. and Australia, to focus future efforts on the assessment of the performance of state ICM programs, for their broader evaluation in a national context.

This calls for more systematic evaluations of ICM efforts, shifting from the use of sole environmental indicators to the use of the PSR model in the context of the ICM cycle. This is particularly needed to demonstrate the socioeconomic benefits of ICM. Integrating environmental, socioeconomic, and governance aspects and developing indicators capable to capture these processes remains one of the most difficult challenges for the ICM approach.

Based on the above discussion, a possible short list of governance indicators is provided in Table 5-14.

Table 5-13 *Summary of indicators for governance response and performance*

Theme	Indicator	Level	UN	OECD	WRI	EEA	BP	Other
Water quality	Percentage of population served by waste-water treatment plants	National Hot spot	●	●			●	
	Existence of monitoring programs concerning pollutants	National					●	
	Harbor equipment ratio in unballasting facilities	National					●	
Biodiversity and landscape	Coastal protected areas	National Local Strip	❍				●	
	Marine protected areas	National	❍				●	
Fisheries	Number of stocks regulated by quotas	National		●				
	Expenditure for fish stock monitoring	National					●	
Information and participation	Preparation of coastal profiles	National	❍					
	Use of coastal indicators	National	❍	●				
	Mechanisms for public opinion on coastal and marine environmental issues	National		❍				
	Coastal chapter in the state of the environment report	National		●				
Human resources	Education and training programs for coastal and marine affairs	National	❍					●
Institutional capacity	Coordinating mechanisms for coastal and marine affairs	National Local	❍	●				●
	Policies and legislation specifically addressing the management of coastal and marine areas	National Local	❍	●				●
	Implementation of land and water use and siting policies and ICM plans	National Local	❍	●				●
	Use of EIA and SEA procedures for coastal areas	National Local	❍	●				●
	Use of economic incentives to apply clean technologies and implement the polluter pays principle	National	❍	●				
	General progress in strategies and plans for ICM	National Local				●		

● Explicitly and currently used

❍ Implicitly or no longer used

Table 5-14 *Suggested list of governance indicators*

Focus area	Indicators
Public Access	• Legal availability (legal mechanisms ensuring public access) • Area by type (description of lands that might be accessible) • Access points (description of types of physical access and areas of access pints) • Quality of experience (description of the usability of the public access points and state of surrounding environment)
Coastal Habitats/ Biodiversity	• Size (area or abundance of populations) • Condition (description of the composition, structure and biotic interactions of populations) • Landscape context (description of dominant environmental regimes influencing composition of populations and the connectivity between populations and ecosystems)
Coastal Community Development	• Environment and land use (description of types of land development in the coastal areas) • Economic (description of economic diversity and positive and negative economic growth) • Social (description of engagement between government and the public) • Public investment and infrastructure (description of alignment between investments and incentives shaping growth and community values)
Coastal Hazards	• Land use and transportation planning (description of coastal area in order to avoid inappropriate development in hazardous areas) • Mitigation, response and recovery (of property owners and government to hazards) • Vulnerability (of property to coastal hazards
Coastal Water Quality	• Pollutant inputs (description of changes in the sources and amounts of pollutants loaded to coastal systems) • Water quality conditions (includes direct and indirect measures of water quality) • Ecosystem effects (description of consequences of changes in water quality in terms of coastal resources)
Coastal Dependent Uses	• Planning and management mechanisms (description of the authority to enact laws and ordinances to protect public health, safety and welfare) • Economic health (measure in physical economics or types of uses and trends in economic development)
Public Awareness and Participation	• Public education programs for specific clients • Mechanisms for public participation and extent of use
Institutional Structures/ Capacity	• Progress in national ICM initiatives (e.g., management plans formulated/adopted/implemented) • National and local government capacity and commitment • Institutional structures • Sustainability
Policy Development	• National ICM legislation • Policy studies • Rules and regulations embodied in local laws/ordinances
Monitoring and Evaluation	• Monitoring and evaluation system • Participation of stakeholders in monitoring and evaluation • Usage of monitoring and evaluation results

Source: Olsen 2002

6. Mapping progress, outcomes and effectiveness of integrated coastal management

6.1 Measuring progress, outcomes and effectiveness

Progress across the policy cycle of integrated coastal management

The nature of ICM as a continuous and dynamic governance process calls for its consideration as a phased cycle subject to learning and adaptation. According to different sources, the cycle can be conceived as made of five major steps:

- Identification and analysis of issues;
- Setting of objectives and preparation of a plan of policies and actions;
- Formalization through a law, decree, or interagency agreement and securing of funding for implementation;
- Policy implementation though the operationalization of activities; and
- Monitoring and evaluation of desired outcomes.

Each step of the ICM cycle is associated with specific priority actions, through which it is possible to monitor and assess the progress of the ICM process (Table 6-1).

Table 6-1 *Priority actions associated with each step of the ICM process*

Step	Indicators
Step 1: Issue Identification and Assessment	• An assessment of the principal environmental, social and institutional issues and their implications. • Identification of the major stakeholders and their interests. • Selection of the issues upon which the ICM initiative will focus its efforts. • Definition of the goals of the ICM initiative. • Active involvement of stakeholders in the assessment and goal setting process.
Step 2: Preparation of the Plan	• Scientific research on selected management questions. • Boundaries of the areas to be managed defined. • Documentation of baseline conditions. • Definition of the action plan and the institutional framework by which it will be implemented. • Development of institutional capacity for implementation. • Testing of Second Order behavioral change strategies at pilot scales. • Active involvement of stakeholders in planning and pilot project activities.
Step 3: Formal Adoption and Funding	• Formal endorsement of the policies/plan and provision of the authorities necessary for their implementation. • Funding required for program implementation obtained.
Step 4: Implementation	• Behaviors of strategic partners monitored, strategies adjusted. • Societal/ecosystem trends monitored and interpreted. • Investments in necessary physical infrastructure made. • Progress and attainment of Third Order goals documented. • Sustained participation of major stakeholder groups. • Constituencies, funding and authorities sustained. • Program learning and adaptations documented.

Focus step	Indicators
Step 5: Self Assessment and external evaluation	• Program outcomes documented. • Management issues reassessed. • Priorities and policies adjusted t• reflect experience and changing social/environmental conditions. • External evaluations conducted at junctures in the program's evolution. • New issues or areas identified for inclusion in the program.

Source: Olsen 2002

Indicators have been developed to assess progress in ICM or the maturity of an ICM program (Chua 1998). In order to provide a rapid evaluation of ICM, these indicators can be used in relation to different levels of the ICM process:

a) *Preparatory activities*, including the establishment of environmental monitoring systems, the preparation of coastal profiles, and the conduct of environmental impact assessments (EIAs) and carrying capacity assessments (CCAs);
b) *Institutional arrangements*, including the establishment of coordinating bodies, the organization of task forces, and the training of staff;
c) *Program implementation*, referring to the formulation and adoption of planning frameworks, management and zoning regulations, sectoral master plans, and application of economic tools;
d) *Surveillance and enforcement*, in relation to the reinforcement of monitoring, surveillance, and control capacity, with particular attention to fishery issues;
e) *Program monitoring and evaluation*, for the periodic assessment and review of the program;
f) *Program sustainability*, in terms of political commitment, institutional capacity, and financial viability; and
g) *Program impacts*, with reference to reduction of conflicts, environmental quality, socioeconomic benefits.

A simple scoring system is used to assess ICM progress: each milestone or output is given one point. Through a composite measure of the indicators, it is possible to have a sense of the progress of the ICM process (Table 6-2). This type of scoring is based on results from interviews and should be validated with the support of further investigation. It is important to note that this type of measurement is referred mainly to process indicators and does not measure the impact of an ICM program. To achieve this, it is necessary to combine information on the performance or progress of ICM programs with information on pressures and states in a defined coastal zone.

Table 6-2 *Checklist to measure ICM progress*

Variable	Indicators and scoring
Preparatory activities and initiation	• Environmental monitoring systems established (1) • Environmental and socioeconomic profiles prepared (1), problems identified and prioritized (1), and management boundaries defined (1) • Program planning undertaken (1) and all relevant stakeholders consulted (1) • Public awareness created (1) • Baseline studies completed (1) • EIA/risk assessment (1) and CCAs conducted (1) • Advanced information management systems established (1)
Institutional arrangements and capacity building	• Interagency steering group established (1) • Advisory expert group established (1) • Training courses for public officials held (1)
Program implementation	• Planning frameworks formulated (1) and adopted (1) • Specific management regulations developed (1) and adopted (1) • Zoning schemes developed (1) and adopted (1) • Sectoral development plans developed (1) and adopted (1)

Variable	Indicators and scoring
Program monitoring and evaluation	• Program monitoring and evaluation protocols developed (1)
Program sustainability	• Attitudinal changes among stakeholders detected (1) • Staff capacity ensured (1) • Major stakeholders participated in program implementation (1) • Financial resources for program continuation committed (1) • CZM program integrated int• local environmental management and sustainable development frameworks (1)
Program impacts	• Environmental quality improved (1) • Interagency conflicts reduced or resolved (1) • Use conflict mitigated or resolved (1) • Evidence of ecological improvement (1) • Evidence of socioeconomic benefits (1)

Source: Chua 1998

Measuring outcomes and effectiveness

The outcomes of the ICM governance process can be broken down into intermediate and final and measured at different geographic scales: local, regional, and national. The outcomes are dependent on the level of development and capacity of the site or country where the ICM process is carried out (Olsen, Tobey et al. 1997).

First order outcomes: Formalized institutional structures and constituencies for ICM. In most cases, ICM programs will have to build the institutional and human capacity to undertake actions with enough mandate, staff, and resources. This is particularly important in order to address eventual interagency conflicts that might make institutional coordination difficult.

Second order outcomes: Correction, mitigation of selected behaviors and/or development actions implemented. After its initiation, an ICM program must be capable of producing outcomes since its inception. These outcomes will be proportioned to the capacity of the program, which will have to demonstrate its ability to influence the behavior of the actors it addresses and implement early actions.

Third order outcomes: Specific improvements in quality of life and the condition of target environmental qualities. Desired impacts in terms of improvements in quality of life and environmental conditions might occur some time after changes in actors' behavior has manifested themselves. Demonstrated results from early implementation actions, therefore, represent an important justification for the ICM program to continue.

Fourth order outcomes: Sustainable environmental quality and quality of life. Over the longer-term, in accomplishment of its ultimate goal, an ICM program should be able to achieve conditions of sustainable development for coastal communities and environments. This can be measured at different geographical scales.

In more detail, indicators of outcomes are represented in Table 6-3.

Table 6-3 *Outcome indicators*

Level of outcome	Indicators
1st Order: enabling conditions	Constituencies that actively support the ICM initiative: • Within the user groups that will be most affected by the ICM program • Within the governmental institutions involved in the program • Within the general public

Level of outcome	Indicators
1st Order	A formal governmental mandate for the program with the authority necessary to implement a course of action: • A law, decree or other high level administrative decision creating an ICM program as a permanent feature of the governance structure • The creation of commissions, working groups, user organizations and non-governmental organizations (NGOs) dedicated to the advancement of an ICM agenda • The designation of protected areas and the enactment of land and water use zoning schemes
	Resources, including sustained annual funding, adequate to implement the plan of action
	A plan of action constructed around unambiguous goals
	The institutional capacity necessary to implement the plan of action
2nd Order: changes in behavior	Changes in the behavior of institutions and interest groups • Collaborative planning and decision making through task forces, commissions, civic associations and the like • Successful application of conflict mediation activities • Evidence of functional public-private partnerships • Collaborative actions by user groups • Use of new school curricula on ICM topics
	Changes in behaviors directly affecting resources of concern • Elimination of destructive fishing practices and over-harvesting • Land use practices that reduce contamination of water, sustain fresh water inflows to estuaries
	Investments in Infrastructure Supportive of ICM Policies and Plans • Construction and maintenance of shoreline protection works • Construction of port facilities and other transportation related infrastructure • Waste disposal and pollution reduction infrastructure including sewage treatment facilities, sanitary landfills, runoff retention basins • Infrastructure to enhance and protect public access to the shore including rights of way, boardwalks, signage programs • Investments in habitat protection and restoration including purchase of protected areas and conservation easements, construction of artificial reefs, installation of mooring buoys
3rd Order: the harvest	Improvements in some coastal ecosystem qualities • Sustained conservation of desired qualities with the areas subject to ICM • Halting or slowing undesired trends such as overfishing, sand and coral mining, eutrophication • Restoration of lost qualities, for example, through re-establishment of water flows to wetlands, sufficient diminution of sediment or nutrient loads to permit light penetration to corals or sea grass beds, control of overexploitation of living resources
	Improvements in some societal qualities: • Increases in indices of quality of life, such as the Human Development Index • Reduced poverty, greater life expectancy, better employment opportunities • Greater equity in access to coastal resources and the distribution of benefits from their use • Greater order, transparency and accountability in how planning and decision making processes occur • Greater security, including food security • Greater confidence in the future and hope
4th Order: sustainable coastal development	Sustainable forms of coastal development over the long term

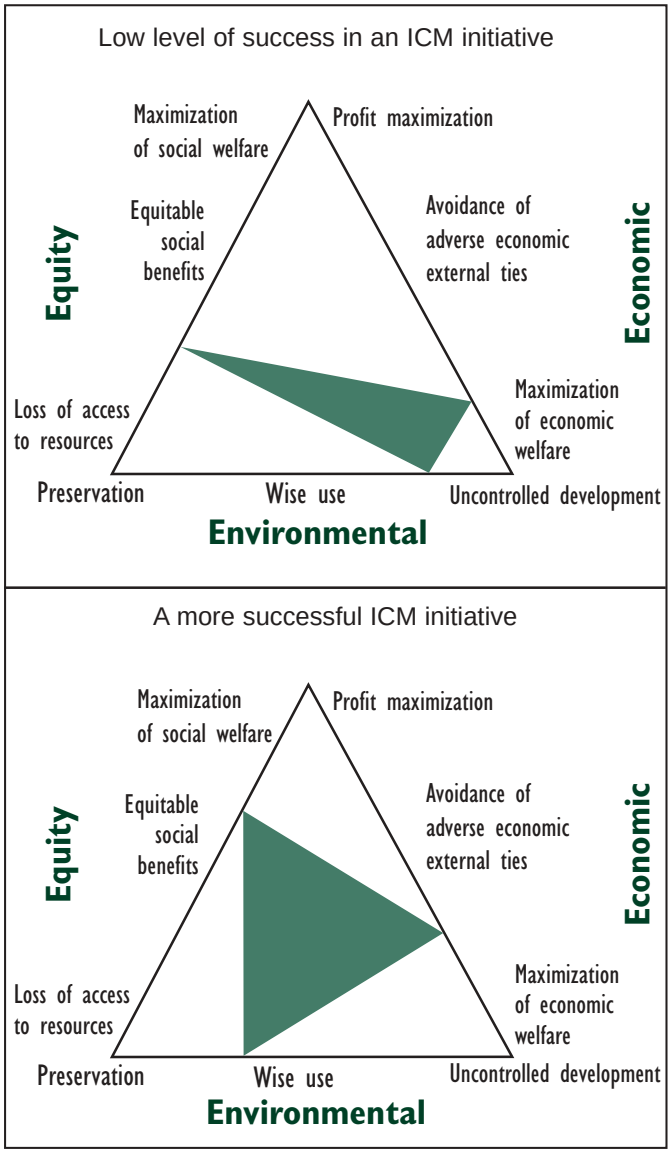
Source: Olsen 2002

Measuring effectiveness

The difficulty of developing and implementing a "generic" framework for measuring success in ICM has been underlined by Burbridge (1997). While there is a general agreement on the sustainable development goals that are pursued by ICM programs—namely, the improvement of the quality of life of coastal communities while maintaining the biological diversity and productivity of the ecosystem—the task of measuring progress towards such goals presents difficulties such as:

- The often unclear definition of the specific objectives of ICM programs;
- The lack of comprehensive and accurate baselines; and
- The inadequacy of scientific data on which indices of ICM progress are based.

Figure 6-1 *Achievement of ICM initiatives (from Brubridge 1997)*



However, progress in ICM can be recognized where policies and actions are implemented that:

- Recognize the socioeconomic importance of coastal resources;
- Build capacity and develop human resources for planning and managing coastal resources in a sustainable way; and
- Facilitate integration of multiple use management of coastal resources into the broader social, cultural, legal, and administrative fabric of a coastal region.

Within the sustainable development paradigm, development opportunities in the coastal area should be pursued without jeopardizing conservation values. UNEP (1999), based on Cendrero et al. (1997), suggests mapping use/development and conservation values and their potential conflicts across two axes.

Such an approach can be used to determine strategies for specific coastal areas, based on the use of environmental impact assessment (EIA) and cost-benefit analysis procedures. Indicators for ICM purposes, therefore, could be developed to assess changes and trends deriving from use conflicts, particularly in relation to:

- Impacts on the use of the territory;
- Impacts on the quantity and quality of natural resources;
- Impacts on the structure and functions of the ecosystem; and
- Impacts on the natural and man-made landscape.

When considering the impacts of ICM initiatives, based on the interrelationships amongst economics, equity, and environment, Burbridge (1997) proposes a diagram to achieve sustainable use of coastal resources through: (a) Minor degradation in the quality of the environment; (b) minimal loss of economic options; and (c) equitable distribution of benefits to local communities.

Figure 6-1 maps on a scale or axis the achievement of an ICM initiative according to three major aspects: environment, economy, and equity. Two scenarios are represented, the first in which uncontrolled development is producing maximization of economic welfare but causing loss of access to resources, and the second where wise use of environmental resources helps avoid adverse economic externalities and achieve equitable social benefits.

Indicators to map specific aspects of environmental, social, and economic components could be identified and a fourth axis added relative to governance processes, particularly in relation to institutional integration and the sustainability of ICM initiatives. The level of abstraction implied in such representation requires that tangible indicators be developed for each of the four components and that an appropriate scaling and weighting system be devised. The evaluation of specific ICM initiatives can only be done on a case-by-case basis, with due regard to geographical, environmental, socioeconomic, and institutional characteristics and appropriate aggregation of indicators for each of the four components. The model, however, could provide some usefulness in comparing national or regional situations.

A limited set of tentative "headline indicators" for ICM could be developed, measurable at the subnational or program level and with a potential for aggregation at the national level into an ICM performance assessment system. Such indicators would provide a useful means to communicate ICM issues to policy makers and the general public. The literature review carried out for this document provides a first step to identify indicators that are able to measure both ICM processes and on-the-ground impacts.

Headline indicators could be selected based on a series of well-established criteria, such as:

- Specific relevance to the coastal zone and sensitivity to changes in coastal phenomena;
- Usefulness for both management purposes and communication to a broader audience;
- Consistent measurability and data availability;
- Threshold or reference values and sustainability targets;
- Outcome-based rather than output-based;
- Spatial aggregation at the national, regional, and eventually international level; and
- Scientific soundness.

Headline indicators built along the PSR framework model could be particularly useful to monitor progress in high priority areas such as:

- Protection of the marine environment from land-based sources of pollution;
- Conservation of coastal and marine biodiversity;
- Preservation of ecosystem health, namely structure and functions;
- Maximization of socioeconomic benefits for key industries dependent on coastal resources (e.g., tourism and recreation, fisheries, shipbuilding);
- Institutional and sectoral coordination and integration; and
- Program sustainability.

6.2 Summary and selected list of governance indicators

Based on the recommended framework for setting indicators for ICM, environmental and socioeconomic indicators may be drawn for the essential elements in the Pressure and State boxes (Human activities, State of Environment and Natural Resources, and Socioeconomic State) while governance indicators may be drawn according to elements under the Response box. Indicators under each category can be differentiated by level/scale of usefulness, into global, regional, national, local, or program/project type of indicator as needed.

Developing indicators with the use of the modified PSR framework and selecting indicators based on multiple sets of criteria are the initial steps in integrating environment, socioeconomic, and governance indicators. The integration process can be carried out further by organizing the final sets of indicators into a logical framework where the objective of rehabilitating a degraded ecosystem is addressed making use of corresponding output indicators (e.g., environmental awareness, "no-take" zones, reduction of destructive fishing practices, increased household income). The output indicators may be governance or pressure indicators that present the accomplishment of intermediate objectives. Sustained achievement of these intermediate objectives will eventually lead to the accomplishment of the desired final impact that is the rehabilitation of the targeted ecosystem. Such logic models may be applied to each program objective. The combined logic models can then be linked together to assess the program's primary goal.

The PSR framework provides a convenient model that can be applied at the stage of coastal management when pressures and other «negative» circumstances are driving the management process. Thereafter, when sustainability, improvement and other positive factors are motivating the process, models such as the Input-Output-Outcome-Impact model may be more appropriate to use.

The PSR and the input-output-outcome-impact models can provide a framework to integrate environmental, socioeconomic, and governance dimensions and the relevant indicators. Governance indicators, or responses, are

most effectively expressed under the input and output categories. Environmental and socioeconomic indicators can be expressed under the outcome, or short-term results, and impact, or long-term results, categories, both in terms of changes in pressures and state. As an example, a tentative framework encapsulating some of the major coastal management issues/opportunities is suggested in Table 6-4.

Table 6-4 *Process and outcome indicators for key ICM issues and opportunities*

Issue/opportunity	Input	Output	Outcome	Impact
Coastline stabilization and protection from hazards	Cost and type of beach replenishment and stabilization structures	Area of beach maintained or created	Creation of new physical support for development activities	Increased recreational areas
	Identification of hazard-prone areas and investment for protection of coastal hazards	Regulations and incentives for appropriate siting in hazardous areas	Relocation of people and structures	Reduction of human, environmental and socioeconomic losses due to coastal hazards
Coastal and marine pollution	Watershed management plans	Watershed development plans	Improvement in the conditions of water quality over a number of parameters: physical, biological (e.g., HAB events), chemical	Improvement in the structure and functions of the ecosystems based on water quality
	Identification and control of point sources of pollution	Regulations for coastal and marine pollution and mitigation measures		Reduction of human diseases associated with water quality
	Investment in infrastructure for wastewater treatment	Percentage of population served by wastewater treatment plants	Increase in the percentage of coastline suitable for bathing and recreation	Socioeconomic benefits from coastal tourism and recreation
	Investment in measures to control marine pollution	Regulations, contingency plans and structures for marine pollution	Reduction of risks associated with oil and hazardous substances	Reduction of oil and chemical pollution at sea and coast
Coastal development	Appropriate siting and relocation of coastal industry and settlements	Land and water use planning and zoning	Reduction of conflicts over coastal utilization	Socioeconomic benefits from coastal activities and goods and services provided by coastal ecosystem services
			Percentage of areas revitalized	
	Investments in urban renovation (e.g., waterfront revitalization	Percentage and type of coastal activities subject to EIA and SEA procedures	Number of tourists and duration of the stay	
	Investment in rehabilitation of coastal derelict areas (e.g., brownfields)			
Biodiversity	Strategies and plans for the conservation and sustainable use of coastal and marine biodiversity	Number and extension of coastal and marine protected areas	Reduction of percentage of endangered and threatened coastal and marine species	Improvement in the structure and function of coastal and marine ecosystems
				Socioeconomic benefits from coastal and marine protected areas
Fisheries	Expenditure for fish stock monitoring, control and enforcement	Percentage of fish stocks regulated for sustainable use	Reduction of damaging fishing practices and equipment	Increase of fish productivity
	Fisheries management plans and regulations			Socioeconomic benefits from fisheries

Issue/opportunity	Input	Output	Outcome	Impact
Information, participation, education and training	Establishment of procedures for public involvement	Number, inclusiveness and transparency of public meetings and hearings	Increased awareness of coastal issues	
	Establishment of education and training programs	Type and number of education and training courses	Number and trained coastal decision makers	
Institutional capacity	Establishment of coordinating mechanisms for coastal affairs	Number and type of agencies participating in coordinating mechanisms	Reduction of interagency and user conflicts	Long-term environmental and socioeconomic benefits of ICM
		MOUs and partnerships between agencies and user groups		
	Policies and legislation specifically addressing the coast	Number of ICM programs and their coastline coverage	Institutional, political and financial sustainability of ICM programs	
	Public and private investments in ICM			

7. Conclusions and recommendations

7.1 Conclusions

There is widespread recognition of the importance of integrated coastal management (ICM) to address the environmental and developmental challenges of coastal zones in a holistic way. Agenda 21, Chapter 17, the Convention on Biological Diversity (CBD), the Barbados Action Plan, the Global Programme of Action for the Protection of the Marine Environment from Land-Based Sources (GPA), the FAO Code of Conduct for Responsible Fishing all call for a cross-sectoral approach to the management of coastal areas.

Guidelines for ICM developed by international organizations, UNEP, FAO, and the EU, in particular, have underlined the relevance of indicators to monitor changes in the state of the coastal and marine environments, assess trends in socioeconomic pressures and conditions in the coastal areas, and appraise the effectiveness of ICM efforts in addressing these issues.

The scientific and technical literature and the practical experience have highlighted the need to develop indicators to assess the performance of the numerous and long-standing ICM efforts developed at all levels. This is particularly true considering the high levels of investments in ICM initiatives by both national and international sources.

An indicator can be defined as a parameter or a value derived from parameters, which provides information about a phenomenon. Indicators useful for coastal management purposes can be classified according to 3 different types: (a) environmental indicators, (b) socioeconomic indicators, and (c) indicators to evaluate ICM efforts.

Coastal indicators can also be classified according to their temporal measurability:

- Measurable in the short-term;
- Measurable in the mid-term; and
- Measurable in the long-term.

As reported by a survey of the OECD in 1997, most countries are currently monitoring a range of environmental quality parameters, typically physical or biological (e.g., in relation to the EU Bathing Quality Directive). Only a few cases report the development of indicators for management processes, to assess whether current or projected uses of the coastal zone are sustainable. Most countries also include a chapter on coastal and marine issues in their periodic state of the environment reports.

Environmental indicators applicable to the coastal zone have been developed within the context of large-scale research program at the global level and are used in the framework of state of the environment reports at the national level, and are eventually incorporated within regional initiatives. Typically, environmental indicators are developed within the PSR framework or extended models and are useful to monitor the state of the coastal and marine environment.

The PSR framework is a typical analysis of causes and effects, driving forces, and responses. It is part of an environmental policy cycle that includes problem perception, policy formulation, monitoring, and policy evaluation, according to the Pressure-State-Response (PSR) framework originally developed by the Organisation for Economic Co-operation and Development (OECD) in

1993 and adopted for the UN sustainable development indicators.

Alternatives to this model include the PSR/effects model developed by the U.S. Environmental Protection Agency (EPA), the PS/impact/R of the United Nations Environment Programme (UNEP), and the Driving forces/PS/impact/R framework adopted by the European Environment Agency (EEA).

Environmental indicators tend to be physical or biological in nature, rather than oriented towards management processes. Many countries are now devoting more attention to the development of indicators that would allow an assessment of whether current or planned uses of the coastal zone are actually sustainable.

While the use of coastal indicators is still limited, various countries appear to have progressed in their application of environment indicators to: (a) Reducing "point" sources of pollution; (b) applying classical land-use planning techniques to coastal zone, protected areas, and (c) providing public access to the beaches.

Pressure and societal response indicators can be considered at a sectoral level. Sectoral disaggregation, including private households as consumers, can be carried out in: (a) Functional sense, relating to source of pollution and (b) institutional sense, relating to economic activities.

On the other hand, examples of socioeconomic indicators intended to describe socioeconomic conditions in the coastal zone are rare at the national level. In state of the environment reports, socioeconomic indicators are developed for broader application and subnational programs are expected to develop specific socioeconomic indicators under various themes including coasts and oceans, based on issue focus that varies from country to country.

It is also a possibility that examples of well-developed socioeconomic indicators for the coastal zone are rare either because monitoring and evaluation systems are not developed at the onset of project planning or are developed but did not intend to cover the measurement of impacts.

Issue-specific global programs such as the Millennium Ecosystem Assessment and the WCPA-Marine program which follow an integrated approach or perspective with a focus on ecosystems and marine protected areas, respectively, have developed socioeconomic indicators. These programs look at both environmental and socioeconomic aspects and their interaction. Marine protected areas programs, in general, value environmental as well as socioeconomic benefits.

Subnational, e.g., state, local, or site-specific coastal management programs, have socioeconomic indicators that describe specific socioeconomic impacts of program components. Within focus areas that are targeted by program components, outputs (process indicators) and impacts including socioeconomic indicators are described.

The use of governance performance indicators for ICM is still in its infancy. Some efforts have been made to monitor progress of ICM at the global (OECD), regional (EU), and program level (most notably by the Coastal Resources Center and PEMSEA). Difficulties are apparent, in particular, in tying ICM efforts to on-the-ground changes and the attribution of effects to ICM programs remains an open issue.

At the program and project level, the input-output-outcome-impact framework developed by the World Bank, as well as the outcome evaluation model, provide an important combined framework. This has to be accompanied by the setting of specific goals and baselines for ICM programs to monitor their effects. On these lines, attempts are being made, for example in the U.S. and Australia, to focus future efforts on the assessment of the performance of state ICM programs, for their broader evaluation in a national context.

This calls for more systematic evaluations of ICM efforts, shifting from the use of sole environmental indicators to the use of the PSR model in the context of the ICM cycle. This is particularly necessary to demonstrate the socioeconomic benefits of ICM. Integrating environmental, socioeconomic, and governance aspects and developing indicators capable of capturing these processes remains one of the most difficult challenges for the ICM approach.

There is no direct relation between indicators for specific purposes (i.e., performance evaluation, reporting on the state of the environment), and specific types of indicators (i.e., indicators of environmental conditions, pressures and social responses). There is no one-to-one correspondence between indicators distinguished by their nature and indicators distinguished by their use.

Good coastal indicators should satisfy a series of conditions:

- Policy relevance and utility for users:
  - Representative picture
  - Easy to interpret/trends over the time
  - Responsive to changes
  - International comparisons
  - National in scope
  - Threshold or reference value
- Analytical soundness:
  - Well founded
  - International consensus
  - Linked to economic models, forecasting and information system
- Measurability:
  - Available at a reasonable cost/benefit ratio
  - Adequately documented and of known quality
  - Up to date.

Coastal indicators can also be assessed from four perspectives:

- The individual core indicators with regards to their definition, their measurement unit, and their ranking on quality criteria;
- The degree to which each set of core indicators covers its policy field;
- The overlap between sets of core indicators among policy fields; and
- The opportunities for the aggregation of core indicators into an index per policy field

The core indicators comprise three different types of indicators: simple, combined and relative. A clear preference exists for combined indicators. Combined indicators are best expressed on the basis of effect-related equivalents.

Recommendations from international organizations—most notably, OECD and EU—have had some influence on ICM processes in the surveyed countries. They have largely supported the general direction of ICM policy development, rather than effectively generating specific new ICM initiatives. It is too early to conclude about long-term effectiveness. Countries have recognized the need for improvement: some countries are progressing from the planning phase of the ICM process to implementation phase.

Following this generic approach it is necessary to focus on environmental coastal indicators. These environmental indicators tend to be physical or biological in nature, rather than being oriented towards management processes. Many countries are now putting more effort into the development of indicators that would allow an assessment of the sustainability of current or planned uses of the coastal zone.

The strengths and weaknesses of indicators are directly related to their linkages with environmental objectives:

- Land use planning and zoning;
- Coastal waters planning;
- Conservation requirements;
- Ecosystem protection and restoration;
- Discharge limits;
- Water quality for receiving waters and waters flowing into coastal zone; and
- Control and reduction of inputs from polluting and hazardous substance.

While coastal indicators have yet to be fully applied, some progress with the application of environment indicators is evident in terms of:

- Reducing "point" sources of pollution;
- Applying classical land-use planning techniques to coastal zone, protected areas; and
- Providing public access to the beaches.

Other strengths and weaknesses of indicators depend on their fundamental characteristics:

- Be based on sound scientific and technical principles;
- Be simple, easy to interpret and capable of revealing trends;
- Be relevant and comparable internationally;
- Have the potential to be linked to economics and other policy fields; and
- Be widely accepted by scientists, policy-makers and the general public.

7.2 Recommendations

Among the recommendations that could be drawn from the literature review on coastal indicators, the following are noteworthy:

- It is important for ICM programs to adopt objective-based outcome evaluations, defining environmental and socioeconomic goals and establishing baselines

against which to measure the impact of ICM initiatives. To this end, the causal relationships linking environmental, socioeconomic, and governance components must be identified.

- Indicators should be user-led and coastal stakeholders should be involved in the process of selection, development and monitoring of indicators from the inception of initiatives. In most cases, given the potential high cost associated with the development of complex indicators, it would be preferable to make the best use of existing information derived from different types of programs. On this basis, an enhanced report on the state of the environment and development of the coastal zone could provide an occasion for collaboration between subnational and national levels for the achievement of shared objectives.
- Existing information could be enhanced by: (a) Compiling baseline information on the condition of ecosystems, (b) standardizing, compiling and harmonizing existing data sets to develop global data sets, (c) identifying areas of high conservation priority, patterns of ecosystem interlinkage, and causal relationships in systems, (d) utilizing multiple methods for monitoring and assessment, (e) improving integration and collaboration among coastal zone agencies and initiatives; and (f) developing techniques for governments and non-governmental organizations to engage policy-makers and civil society for better evaluation of trade-offs and improved decision making.
- Monitoring and evaluation mechanisms should be incorporated from the beginning of a program, while program monitoring must be linked to evaluation throughout project implementation. This means that indicators must be set as an integral part of a program or project proposal, and revised accordingly as adjustments to project objectives, interventions, and implementation mechanisms are made.
- The development of mechanisms such as the coastal module of GOOS should be supported to enable regular ecosystem assessments and improve sustainable development and management of global coastal ecosystems.
- An indicator system for ICM could be developed to link environmental and socioeconomic indicators with indicators to monitor progress in ICM. The indicator system itself could be developed through a phased approach tied to the ICM cycle. This could also provide for the identification of best practices in the use of coastal indicators and their broader applicability.
- The use of headline indicators for ICM appears particularly important: headline indicators could be developed based on combined indicators expressing more complex phenomena or effect-related equivalents. Headline indicators for ICAM should be selected according to the following characteristics: Policy relevance, predictability, interdependency, measurability, and performance.

- Indicators must be anchored to a generic framework of ICM in order to:
  - Promote a more community-based approach to coastal management, increasing public participa tion in ICM planning and decision-making.
  - Place more emphasis on ICM programs and activ ities in the development of indicators.
  - Give proper attention to the development and monitoring of ICM indicators.
  - Focus on the resolution of international ICM problems, using a regional approach.
  - Re-examine the effectiveness of ICM policies through time.
- In the development and application of coastal indicators a series of principles should be taken into account:
  - Indicators provide one of the tools in the process of performance evaluation and need to be sup plemented by other qualitative and scientific information.
  - There is no unique normalization for the compar ison of environmental variables across countries.
  - The core sets of indicators developed by OECD and the EEA are a fundamental basis for the development of environmental indicators.
  - In conceptual and empirical terms, indicators of societal responses tend to be less advanced than indicators of environmental pressures or indica tors of environmental conditions. Thus, particular attention must be given to setting and using socioeconomic indicators.
  - For performance evaluation, indicators must be reported and interpreted in the appropriate con text, taking into account the ecological, geograph ical, social, economic and structural features of countries.
  - Not every area of assessment lends itself to the use of quantitative information. Certain policy areas my assessed in qualitative terms.
  - Environmental issues do not necessarily have a one-to-one correspondence with identified indi cators.

More research should be conducted in: (a) Identifying and relating indicators and issues and (b) association of indicators from one country or area or sector. More efforts should also be initiated on: (a) pollution burden and lack of managing natural resources in sustainable way, (b) integration of environmental and economic or sectoral policies, and (c) international cooperation.

The use of indicators must be useful for solving the deficiencies in coastal policy:

- Policy objectives and integration
  - Policy deficiency
  - Intervention deficiency
  - Market failure
- Policy instruments
  - Absence or inadequacy of information
  - Lack of co-ordination among the many stake holders operating in the coastal zone
  - Poor demarcation of responsibilities between administrative agencies
  - Lack of accurate targeting of the appropriate instrument
  - Poor implementation of policies
  - Lack of evaluation and monitoring
- Fisheries
  - Over-exploitation of resources
  - Unsustainable situation
- Tourism
  - Rapidly growing
  - Lack of preventive action to assure sustainable development
- International waters
  - Lack of particular scope for improvement on international action

Issues of weighting and presentation come into play in the aggregation of the core indicators into one index. Weights could be derived by considering the impacts of particular pressures. An ideal index could be visualized as a tree diagram.

In this respect, the following areas are recommended for future research:

- Evaluation and redefinition of the core of indicator development, that aims to avoid overlap among indicators dealing with similar environmental pressures.
- Evaluation of the coverage of policy fields for which indicators are available.
- Quantification of core indicators, specifically for the combined or aggregated core indicators.

8. References

Blue Plan. 2000. Mediterranean Commission on Sustainable Development--Indicators for the Sustainable Development in the Mediterranean Region: Glossary. Sophia Antipolis: Blue Plan.

Blue Plan and METAP. 1998a. Regional Capacity Building Programme - Programme Performance Monitoring and Indicators: Environmental Performance Indicators--Final Report of the Three Sub-regional Mediterranean Workshops. Sophia Antipolis: Blue Plan.

Blue Plan and METAP. 1998b. Sub-regional Workshop Environmental Performance Indicators: Frame Document--Cairo, 8-10 November 1998; Split, 26-28 November 1998. Sophia Antipolis: Blue Plan.

Bunce, L., Townsley, P., Pomeroy, R., Pollnac, R. (2000). Socioeconomic Manual for Coral Reef Management. Townsville: Australian Institute of Marine Science.

Burbridge, P.R. A generic framework for measuring success in integrated coastal management. Ocean & Coastal Management 3 (1997): 175-189.

Cendrero A. et al. 1997. A procedure for assessing the environmental quality of coastal areas for planing and management. *Journal of Coastal Research* 13 (3°; 732-744.

Chua Thia-Eng. 1998. Lessons learned from practicing integrated coastal management. Ambio 27(8):599-610.

Cicin-Sain, B. and R. W. Knecht. 1998. Integrated Coastal Management: Concepts and Practices. Washington, D.C.: Island Press.

Commission on Geosciences, Environment and Resources (CGER). 2000. Ecological Indicators for the Nation. Washington, D.C.: National Academy Press.

Commonwealth of Australia. 1999. Australia's Oceans Policy. Canberra: Commonwealth of Australia.

Conference of the Parties to the Convention on Biological Diversity (CBD COP). 1998. Report of the Workshop on the Ecosystem Approach. Lilongwe, Malawi, 26 - 28 January 1998. UNEP.

Cordah Ltd (2001). Indicators to Monitor the Progress of Integrated Coastal Zone Management: A Review of Worldwide Practice. Edinburgh: Scottish Executive.

Costanza, R. et al. 1997. The value of the world's ecosystem services and natural capital. Nature 387: 252-259.

Courtney, C.A., R. C ruz, E. Deguit, R. Fuentes, C. Gestopa, S. Green, R. de Leon, E. Leung, E. Melana, W. Jatulan, P. Sayson, A. White and A. Yambao. 2001. Guidelines for annual monitoring and evaluation of municipal/city coastal resource management plans and programs for certification. CRMP Document No. 46-CRM.

Daler, D. 2002. A briefing of the results of Scoping from several sub-regions around the world. GIWA Newsletter 1.

Daler, D., E. Rautalauti-Miettinen and S. Gräslund. 2001. Assessing the status of international waters. Limnology and Oceanography Bulletin 10(3):37-41.

Doody, J. P., C. F. Pamplin, et al. 1999. Information Required for Integrated Coastal Zone Management, European Commission. 1999.

EC/Eurostat. 1999. Towards Environmental Pressure Indicators for the EU: Indicator Definition. Brussels: EC/Eurostat. Available: http://www.e-m-a-i-l.nu/tepi/EPI%20Indicator%20Definition.pdf) .

EcoHealth Consulting, D.J. Rapport. 2001. International Inventory and Scientific Review of Indicators, Surrogate Measures and Other Parameters for Marine Environmental Quality. Part I. Ed. Environment Canada. Guelph: Canada.

EcoHealth Consulting, J. Dalgleish. 2001. International Inventory and Scientific Review of Indicators, Surrogate Measures and Other Parameters for Marine Environmental Quality. Part II. Ed. Environment Canada. Guelph: Canada.

Environment Canada. 2002. Genuine Progress Index (GPI) for Atlantic Canada. 2002. The Nova Scotia GPI Fisheries and Marine Environment Accounts, Tantallon: Canada.

Envirosphere Consultants Ltd. 2000. Monitoring Marine Ecosystem Health—Canadian Perspective. Windsor, Nova Scotia: Envirosphere Consultants Ltd.

FAO. 1998. Integrated Coastal Management and Agriculture, Forestry and Fisheries. Rome: FAO.

FAO Fishery Resources Division. 1999. Indicators for sustainable development of marine capture fisheries. FAO Technical Guidelines for Responsible Fisheries. No. 8. Rome, FAO. 1999. 68p. Available:

Firn Crichton Roberts Ltd and Graduate School of Environmental Studies University of Strathclyde. 2000. An Assessment of the Socio-Economic Costs & Benefits of Integrated Coastal Zone Management.

Fisheries and Oceans Canada. 1997. Ensuring the Health of the Oceans and Other Seas. Ottawa: Canada.

Florida Coastal Management Program and Florida Department of Community Affairs. 2000. Florida Assessment of Coastal Trends (FACT). Tallahassee, FL: The Department of Community Affairs.

French Institute of the Environment. 1998. Testing United Nations Indicators of Sustainable Development: Summary of Results.

Gardiner, R. 2002. Oceans and Seas: Harnessing the Marine Environment for Sustainable Development. Briefing Paper, Towards Earth Summit 2002.

GESAMP. 2001. A Sea of Troubles. GESAMP Report and Studies 70. UNEP.

Global International Water Assessment (GIWA). 2002. Available at: http://www.giwa.net.

Government of Canada. 2002a. Canada's Ocean Strategy. Ottawa: DFO.

Government of Canada. 2002b. Policy and Operational Framework for Integrated Management of Estuarine, Coastal and Marine Environments in Canada. Ottawa: DFO.

Government of Finland, UNEP and PAP/RAC. 1998. Assessment of Integrated Coastal Management in Africa. Priority Actions Programme Regional Activity Centre, UNEP/MAP, Split, Croatia. viii+72 p.

Harrison, T. and Taljard, S. 2001. Development of Core Set of Indicators for State of the Environment Reporting. Coastal and Marine Indicators. Environmentek, CSIR.

HEED 1998. Health Ecological and Economic Dimensions of Global Change Program. Marine Ecosystems: Emerging Diseases As Indicators Of Change. Health of the Oceans from Labrador to Venezuela. Year of the Ocean Special Report. NOAA- OGP and NASA Grant number NA56GP 0623. (Eds.) P. R. Epstein, B. H. Sherman, E. S. Siegfried, A Langston, S Prasad, B. Mckay. December 1998.

Heinz Center for Science, Economics, and the Environment. 2002. Coastal Zone Management: Performance Indicators and Measures Study. Draft Presented at the National Program Managers' Meeting in Silver Spring, MD, March 2002. Washington, D.C.: NOAA.

Heinz Center for Science, Economics, and the Environment. 1999. Designing a Report on the State of the Nation's Ecosystems: Selected Measures of the Condition of Croplands, Forests, and Coasts and Oceans. Available: http://www.us-ecosystems.org/

ICLEI. 1996. The Local Agenda 21 Planning Guide: An Introduction to Sustainable Development.

Izzo, G. 1997. Marine and Coastal Environment: Annual Summary Report 1996. Topic report No 2/1997. Copenhagen: EEA.

Izzo, G. 1998. Marine and Coastal Environment: Annual Topic Update 1997. Topic report No 3/1998. Copenhagen: EEA.

IUCN. 1991. Caring for the Earth: A Strategy for Sustainable Living. Gland: IUCN.

Lowry, K., S. Olsen, and J. Tobey. Donor Evaluations of ICM Initiatives: What can Be Learned from Them. Ocean & Coastal Management 42.9 (2001): 747-765.

METAP. 1998. Assessment of Integrated Coastal Area Management Initiatives in the Mediterranean: Experiences from METAP and MAP (1988-1996). Split: METAP and PAP/RAC.

Millennium Ecosystem Assessment Sub-Global Component: Purpose, Structure and Protocols (PDF). 2001. Available: http://www.millenniumassessment.org/en/assessments/overview.pdf

Millennium Ecosystem Assessment. http://www.millenniumassessment.org/en/assessments/index.htm

New Zealand, Environmental Indicators Performance Programme. "Marine Indicators" Available: http://www.marine.mfe.govt.nz/

NOAA. 2002a. National Coastal Zone Indicators: An Assessment of Indicator Use and Potential in Five Coastal States. Draft Presented at the National Program Managers' Meeting in Silver Spring, MD, March 2002. NOAA, Washington, D.C.

NOAA. 2002b. Performance Measurement: How Can We Measure Success? Who is Measuring What? How Do We Get There From Here? Office of Ocean and Coastal Resource Management (OCRM) Program Managers' Meeting.

Nygaard, K., B. Rygg, et al. 2001. Marinebase: Database on aggregated data for the coastline of the Mediterranean, Atlantic, North Sea, Skagerrak, Kattegat and Baltic. Technical report No 58. Copenhagen: EEA.

Oceans Canada. 2002. Available: http://www.dfo-mpo.gc.ca/oceanscanada/

OECD. 1993. OECD Core Set of indicators for environmental performance reviews: A synthesis report by the Group on the State of the Environment. Paris: OECD. Available: http://193.51.65.78/env/docs/gd93179.pdf

OECD. 1993. OECD Core Set of Indicators for Environmental Performance Reviews. Environment Monographs No. 83. Paris: OECD.

OECD. 1997. Integrated Coastal Zone Management: Review of Progress in Selected OECD Countries. Paris: OECD.

OECD. 1998. Development Indicators: Methodological Note. DCD/DAC(98)6/ADD. Paris: OECD.

Olsen, S., J. Tobey and L.Z. Hale. 1998. A Learning-Based Approach to Coastal Management. Ambio 27: 611-619.

Olsen, S., J. Tobey, et al. 1997. A Common Framework for Learning from ICM Experience. Ocean & Coastal Management 37(2): 155-174.

Olsen, S., K. Lowry, et al. 1999. A Manual for Assessing Progress in Coastal Management. Coastal Management Report no. 2211. Naragansett, RI: Coastal Resources Center.

Peronaci, M. 1999. Marine and Coastal Environment: Annual topic update 1998. Topic report No 4/1999. Copenhagen: EEA.

Peronaci, M. 2000. Marine and Coastal Environment: Annual topic update 1999. Topic report No 11/2000. Copenhagen: EEA.

Peronaci, M. 2001. Marine and Coastal Environment: Annual topic update 2000. Topic report No 11/2001. Copenhagen: EEA.

Schwabe, C., Viljoen, J. and O'Donovan, M. 2001. South Africa Environmental Indicator Project. Specialist Review. Serial Issues. MSRC.

Saunders, D., C. Margules and B. Hill. 1998. Environmental Indicators For National State of the Environment Reporting – biodiversity, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

Smeets, E. and R. Waterings. 1999. Environmental Indicators: Typology and Overview. Technical report No 25. Copenhagen: EEA.

South Africa, National State of the Environment Report. 1999. Available: http://www.ngo.grida.no/soesa/nsoer/issues/coast/index.htm

The Integrated, Strategic Design Plan for the Coastal Ocean Observations Module of the Global Ocean Obervations Syst. *GOOS Report No. 126.* IOC Information document. Series No.11B3. UNESCO 2003.

UNDP (n.d.). Capacity Assessment and Development in a Systems and Strategic Management Context. Technical Advisory Paper no. 3. New York: UNDP.

UNEP. 1995. Guidelines for Integrated Management of Coastal and Marine Areas: With Special Reference to the Mediterranean Basin. Nairobi: UNEP.

UNEP. 1996. Guidelines for Integrated Planning and Management of Coastal and Marine Areas in the Wider Caribbean Region. Kingston: UNEP Caribbean Environment Programme.

UNEP/MAP/PAP. 1999. Conceptual Framework and Planning Guidelines for Integrated Coastal Area and River Basin Management. Split: Priority Actions Programme.

UNEP, MCSD, et al. 2001. The System of 130 Indicators for the Sustainable Development in the Mediterranean Region: Record of the Workshop in Sophia Antipolis, 11-12 December 2000. Sophia Antipolis: Blue Plan.

United Nations Commission on Sustainable Development. 1992. Agenda 21. Chapter 17: Protection of the oceans, all kinds of seas and coastal areas. Available: http://www.un.org/esa/sustdev/indisd/english/chap17e.ht.

United Kingdom Sustainable Development – The Government's Approach. 2002. Available: http://www.sustainable-development.gov.uk

UK Government. 1999. A better quality of life: a strategy for sustainable development for the UK. London: The Stationery Office.

United Nations and World Bank. 2001. Indicators of Sustainable Development: Guidelines and Methodologies. New York: United Nations.

United Nations Commission on Sustainable Development. 2001. Guidelines for Developing a National Programme of Indicators of Sustainable Development. Available: http://www.un.org/esa/sustdev/indisd/isd-ms2001.htm

United Nations Commission on Sustainable Development. 2001. Indicators of Sustainable Development: Guidelines and Methodologies. Washington, D.C.: United Nations, 2001.

United Nations Department of Economic and Social Affairs. 1997. Earth Summit+5: Special Session of the General Assembly to Review and Appraise the Implementation of Agenda 21. Available: http://www.un.org/esa/earthsummit/ga97nat.htm

University of Massachusetts Boston Urban Harbors Institute. 2002. Establishing Baseline Information on Environmental Indicators and Performance Measures for the National Estuarine Research Reserve System. Draft Presented at the National Program Managers' Meeting in Silver Spring, MD, March 2002. Washington, D.C.: NOAA.

van Elburg-Velinova, D., C. Perez Valverde, et al. 1999. Progress of ICZM Development in European Countries: A Pilot Study. Working Document 1999 (Final). Leiden: EUCC.

Vaz, S. G., M. Jock, et al. 2001. Reporting on environmental measures - Towards more 'sound and effective' EU environmental policies. Environmental Issue Report No 25. Copenhagen: EEA.

World Resources Institute (WRI). 2001. Pilot Analysis of Global Ecosystems: Coastal Ecosystems. Washington, D.C.: WRI.

Wright, K. and C. Russel. 2001. Data Collection Guidelines for the Kiev Report. Technical Report 66. Copenhagen: EEA.

Vandermeulen, H. 1998. The development of marine indicators for coastal zone management. Ocean & Coastal Management 39:63-71.

Ward, T., E. Butler and B. Hill. 1998. Environmental Indicators for National State of the Environment Reporting – Estuaries and the Sea, Australia: State of the Environment (Environmental Indicator Reports), Department of the Environment, Canberra.

WCPA Marine/WWF International. 2001. Draft workshop report. MPA Management Effectiveness Indicator Workshop, Venezuela, October 29-Nobember 2, 2001. 3+p.

World Resources Institute (WRI). 2001. Pilot Analysis of Global Ecosystems: Coastal Ecosystems. Washington, D.C.: WRI.

9. Glossary

Accountability	Obligation to demonstrate that work has been conducted in compliance with agreed rules and standards or to report fairly and accurately on performance results vis a vis mandated roles and/or plans.
Assessment	A process (which may or may not be systematic) of gathering information, analyzing it, then making a judgement on the basis of the information.
Beach stabilization	Activities undertaken to maintain or modify beach processes for improved human utilization e.g. beach replenishment, construction of groins, seawalls, and ramparts.
Catchment management	Management of land usages in the coastal stream and river runoff areas for lagoons, bays, and estuaries.
Coastal population	Numbers and locations of people in coastal towns, cities, and agricultural regions.
Compliance	The act of meeting set rules, regulations or agreements.
Cost-effectiveness	Comparison of the relative costs of achieving a given result or output by different means (employed where benefits are difficult to determine).
Descriptive indicators	Descriptive indicators, often based on the DPSIR framework, describe the state of the environment and environmental issues at the scale for which they are measured.
Driving force indicators	Indicators for driving forces describe the social, demographic and economic developments in societies and the corresponding changes in life styles, overall levels of consumption and production patterns.
Effectiveness	The improvement of the quality of life of coastal communities while maintaining the biological diversity and productivity of the ecosystem through an ICM program.
Effects	Intended or unintended changes resulting directly or indirectly from a development intervention.
Efficiency	A measure of how economically inputs (funds, expertise, time, etc.) are converted into outputs.
Environmental indicators	Environmental indicators reflect trends in the state of the physical environment, help the identification of priority policy needs and the formulation of policy measures, and monitor the progress made by policy measures in achieving environmental goals.

Evaluation	A systematic (and as objective as possible) examination of a planned, ongoing or completed project. It aims to answer specific management questions and to judge the overall value of an endeavour and supply lessons learned to improve future actions, planning and decision-making. Evaluations commonly seek to determine the efficiency, effectiveness, impact, sustainability and the relevance of the project or organisation's objectives. An evaluation should provide information that is credible and useful, offering concrete lessons learned to help partners and funding agencies make decisions.
Governance	The process by which policies, laws, institutions and decision-makers address the issues of concern to a society. Governance questions the fundamental goals, and the institutional processes and structures that are the basis of planning and decision-making
Governance indicators	These indicators measure the progress and quality of the governance process, the extent to which a program is addressing and solving the issue/s that led to the creation of the program
Impacts	The changes in the lives of rural people, as perceived by themselves and their partners at the time of evaluation, plus sustainability-enhancing change in their environment to which the project has contributed. Changes can be positive or negative, intended or unintended. In the logframe terminology these "perceived changes in the lives of the people" may correspond either to the purpose level or to the goal level of a project intervention.
Impact indicators	Indicators that describe changes in the social and economic functions of the environment after changes due to human pressures on the environment. – is it only changes in the economic and social functions? Perhaps this should include all pressures on the environment – not just human?
Indicators	A parameter or a value derived from parameters, which provides information about a phenomenon.
Input	The financial, human and material resources necessary to produce the intended outputs of a project.
Local Agenda 21	A comprehensive plan of action developed at UNCED that is undertaken at the local level to promote the sustainable development of a town, municipality or a city
Logical Framework Approach (LFA)	A project indicator framework used by the World Bank, based on the Input-Output-Outcome-Impact model
Management	Process by which human and material resources are organized to achieve a known goal within a known institutional structure or governance. Management typically refers to organizing the routine work of a unit of a company or a governmental agency.
Management capacity evaluation	Evaluations carried out to assess the adequacy of structures and processes to perform ICM tasks and activities.
Marine Protected Areas	Geographically delimited coastal or marine area, managed according to an established set of conservation or sustainable development oriented principles, rules and guidelines.
Outcome	The results achieved at the level of "purpose" in the objective hierarchy. Outcomes of the ICM governance process can be broken down into intermediate and final and measured at different geographic scales: local, regional, and national levels.
Outcome evaluation	Evaluations that aim at assessing the impacts of developmental and environmental management efforts in environmental physical environment and socioeconomic terms.

Output	The tangible (easily measurable, practical), immediate and intended results to be produced through sound management of the agreed inputs. Examples of outputs include goods, services or infrastructure produced by a project and meant to help realise its purpose. These may also include changes, resulting from the intervention, that are needed to achieve the outcomes at the purpose level.
Performance	The degree to which a development intervention or a development partner operates according to specific criteria/standards/guidelines or achieves results in accordance with stated goals or plans.
Performance evaluation/ measurement	A system for assessing performance of development interventions against stated goals.
Performance indicator	A variable that allows the verification of changes in the development intervention or shows results relative to what was planned.
Pressure indicators	Indicators that describe the pressures exerted by human activities on the environment in terms of release of pollutants, physical and biological agents, use of resources and land.
Pressure-State-Response framework	A typical analysis of causes and effects, driving forces, and responses. It is part of an environmental policy cycle that includes problem perception, policy formulation, monitoring, and policy evaluation.
Process evaluation	An evaluation of the internal dynamics of implementing organizations, their policy instruments, their service delivery mechanisms, their management practices.
Proxy indicator	An appropriate indicator that is used to represent a less easily measurable one.
Qualitative information	Information that is not summarised in numerical form, such as minutes from community meetings and general notes from observations. Qualitative data normally describe people's knowledge, attitudes or behaviours.
Quantitative information	Information that is measured or measurable by, or concerned with, quantity and expressed in numbers or quantities.
Response indicators	Indicators that refer to responses by groups (and individuals) in society, as well as government attempts to prevent, compensate, ameliorate or adapt to changes in the state of the environment.
State indicators	Indicators that describe in quantitative and qualitative terms physical, chemical and biological characteristics and phenomena in a certain area.
Sustainability indicators/ Sustainable development indicators	Indicators that measure the likelihood that the positive effects of a project (such as assets, skills, facilities or improved services) will persist for an extended period after the external assistance ends.
Validity	The extent to which something is reliable and actually measures up to or makes a correct claim. This includes data collection strategies and instruments.

APPENDIX 1

International Workshop

The role of indicators in integrated coastal management

Ottawa, April 29-May 1, 2002
WORKSHOP REPORT

INTRODUCTION

The international workshop on *The Use of Indicators in Integrated Coastal Management* was an initiative of the Department of Fisheries and Oceans, Canada, and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, conceived in the context of IOC 33rd Executive Council of 2000. The workshop, co-sponsored by the U.S. National Oceanic and Atmospheric Administration (NOAA) and the International Geographical Union (IGU), was held on April 29-May 1, 2002 in Ottawa at the Lord Elgin Hotel. The Center for the Study of Marine Policy of the University of Delaware acted as organizer and secretariat.

The aims of the workshop were to:

1. Assess the state of the art in the development and use of different types of indicators—environmental, socioeconomic, and governance performance—to monitor the effectiveness of integrated coastal management (ICM) efforts;
2. Review selected national and local case studies in the application of coastal management indicators; and
3. Develop a common framework and template for the selection and application of coastal management indicators in different contexts.

The workshop was attended by 40 participants from 11 countries: Australia, Canada, France, Italy, Jamaica, Netherlands, Philippines, South Africa, Spain, Tanzania, USA (see the attached list of participants).

The Secretariat provided the participants with a background document based on a literature review on the development and use of indicators for ICM. The background document provided the basis for discussion at the workshop working groups.

The workshop featured 12 lectures divided into four sections: (1) introductions to different types of indicators; (2) case studies from international programs; (3) case studies on the application of indicators; and (4) frameworks for the use of indicators for ICM (*see the attached workshop program*).

Participants attended working groups addressing, for each major class of indicators (environmental, socioeconomic, governance), crosscutting issues such as quantitative objectives, goals, and scale of application of indicators; outcome mapping and measurement of performance; and integration of different types of indicators to address specific policy issues. The results of the working groups were then discussed in plenary for the adoption of practical recommendations targeted to the user community.

The outcomes of the workshop consisted of:

- A discussion on the possible frameworks that could be used to integrate different types of indicators in ICM programs and plans;
- A tentative list of indicators for measuring environmental state, socioeconomic pressures and conditions, and governance performance; and
- A discussion on the shortcomings of indicators.

As a follow-up to the event, the following actions were agreed upon:

- The operation of an electronic discussion group (icm-indicators@udel.edu) to advance the discussion on indicators on ICM among participants;
- The enhancement of the workshop Web site (http//www.udel.edu/CMS/csmp/indicators/), through the uploading of the workshop materials (papers and presentations) and the development of links to programs and initiatives on indicators;
- The refinement of the background document based on further literature sources;
- The preparation of a methodological guide on the use of indicators for ICM, to be published by IOC; and
- The preparation of a special issue of the *Ocean & Coastal Management journal* on the use of indicators for ICM.

GENERAL SUMMARY

Integrated coastal management (ICM) is intended to address the difficult problem of managing overlapping jurisdictions, resolving conflicts among ocean users, and balancing environmental health with economic development. The first steps of the management cycle are problem identification, setting of objectives and the development of management strategies. Towards the end of the cycle, evaluation determines whether management has been successful. Monitoring is used at several stages of the management planning cycle to inform the evaluation process.

Monitoring however, can rise to a large suite of possible indicators. It is therefore necessary to have some sort of framework for grouping indicators. The framework should identify indicators of the ecosystem under study. It should identify human uses of the coastal area and link these to the health of the environment. It should identify opportunities for, and impacts on, the marine environment. The framework should include indicators of management intervention and of the outcomes of intervention. Finally, the framework should address the sustainability of the management process and answer the question "will this management process continue after external sources of funding have been withdrawn?" The Environmental Indicators Working Group of the International Workshop on the Role of Indicators in Integrated Coastal Management was charged with the task of proposing a framework for ICM indicators that would meet the above objectives.

The scope of an Indicator Framework should be broad enough to capture the complexity of information and action that ICM requires. For example, it should allow for a variety of disciplines to assess the state of the coastal system. It should encompass science to understand coastal ecosystem dynamics and the resiliency of these systems to human pressures and interventions. It should embrace indicators of the economic and political system within which interventions are made. It should incorporate indicators of the social and cultural values relating to coastal use. Finally, an indicator framework should include measures from both the land and the sea. Watersheds influence coastal waters, but marine industries also affect the pattern of land use planning.

The working group did not discuss issues of scale in the indicator framework, but the presentations by J. Rice and M. Hatziolos as well as discussion at the plenary session raised a number of scale-related issues that need to be addressed. Here the concept of scale refers to a geospatial and temporal context, and cuts across the ecological, economic, socio-cultural and political frames of reference. An indicator framework should be useful at various scales: National, sub-national and local levels, and while the indicators should make sense at each level, they should also lend themselves to aggregation at higher levels. For example, at a local beach, it may be useful to measure the concentration of marine pathogens in units of individuals per litre. However at the national level, it might be more appropriate to express this indicator as the percentage of beaches at which the pathogen concentration exceeds a target limit. The requirement for aggregation implies that the indicator framework would be common to all levels, that indicators would measure the same phenomenon at different scales, but the units of measurement may differ among scales. Consistency of measurement within a scale, and at different sites is important, however, for comparative purposes, and particularly where transboundary management is required.

The form of the indicator framework discussed here borrows from the ideas of the Workshop presenters, R. Bowen, P. Christie, C. Ehler, S. Olsen, and T. Smutylo. It is based partly on the pressure – state – response (PSR) models which have been developed largely for 'state of the environment' reporting, but it is modified to address measures of the outcomes of intervention, and particularly the sustainability of such outcomes. The advantage of the P/S/R model is that in addition to providing a pic-

ture of the marine environment, it is also useful for defining a set of indicator "targets" to set the objectives for a management plan (cf. Figure 4). The objectives may include aspects of human use, development opportunities, institutional structure, and governance policies in addition to environmental objectives.

Elements of an Indicator Framework

The basic form of the framework is presented in Figure 1. Indicators grouped under 'State of the Environment' define the status or health of the marine ecosystem. Factors which modify the coastal ecosystem, yet are not under management control are grouped under the heading 'forcing'. Indicators grouped under 'Pressures' are human activities that affect the ecosystem. They may be marine-based or land-based. Sometimes they have little effect upon the ecosystem but conflict with other types of coastal use, and thus they impact upon goods or services derived from the coastal zone. Changes in the state of the environment often have an impact on coastal goods and services. An analysis of the state of the environment and the impacts on goods and services leads to a response in governance. Frequently, interventions taken under the heading of 'governance response' will require comparison of the environmental state to a 'reference state'. This may be a similar environment, but lacking the human pressures, or it may be the environment under study, at an earlier state of development. Indicators of governance response can be grouped under 'inputs', 'process' and 'outputs'. The red arrow in Figure 1 indicates that responses in governance, otherwise known as interventions, are intended to change human activities with respect to coastal use. This feedback then results in primary and secondary outcomes of the ICM process.

The basic PSR model shown in Figure 1 however, has been modified in order to introduce 'Governance' and 'Outcome' indicators that allow the following key questions to be answered:

- "Why is ICM not working?" … (in the event that it is not working).
- "Will the ICM process be sustainable?" … (when outside funding is withdrawn).
- "How can one attribute 'success' in ICM to specific interventions?" … (when there are many extraneous effects which come together to bring about changes in the coastal zone).

The final monitoring framework (Figure 2) was developed using the example of a single use, namely sewage effluent in the coastal zone, as the issue under consideration. However, the framework would normally be used to define and group indicators for all other uses of the coastal zone as well. An explanation follows, of the various types of indicator that might be found in each framework component. The reader is asked to consider, as an example to illustrate the framework, nutrient loading and pathogen introduction to the coastal zone as a result of human settlement in the contiguous water basin. This might result in changes to the environment such as eutrophication, and bacterial contamination, which then impacts on use of coastal zone for aquaculture and recreation. The governance response is a series of interventions, which modify the pressures on the environment and result in outcomes that restore the quality of the coastal water.

Forcing Forcing refers to those "natural" phenomena that are not subject to human intervention, and to human pressures that are not normally subject to control. An example of the former would be characteristics of the watershed such as geomorphology, rainfall patterns and hydrological variability. An example of the latter would be the population density near the coast and the rate of human immigration. While these 'forcing variables' are not normally subject to human control, they can modify the management outcomes significantly.

Pressures (Human Activities) Pressures refer to the effect of human activities upon the marine environment. They tend to be measured as rates. Examples with respect to the sewage example would be the percentage of people in the coastal area who are served by sewage treatment facilities, the rate of nutrient loading to marine waters, and the rate of delivery of pathogens, organic and toxic material to the sea.

State of the Environment These indicators refer to the status of environmental conditions. The measurements tend to have unit of amounts or concentrations. For example, the concentration of nitrogen, phosphorus and oxygen indicate the nutrient status of the receiving water; the E. coli concentration indicates the level of pathogens in the water; and the concentration of toxic contaminants indicates the pollution load. The 'state of environment' indicators are often compared to indicators from a 'reference state'. The reference state is simply a set of values for the environmental indicators which represents desired conditions. When there is a discrepancy between the state of the environment (actual con-

Figure 1 *Basic form of an indicator framework*

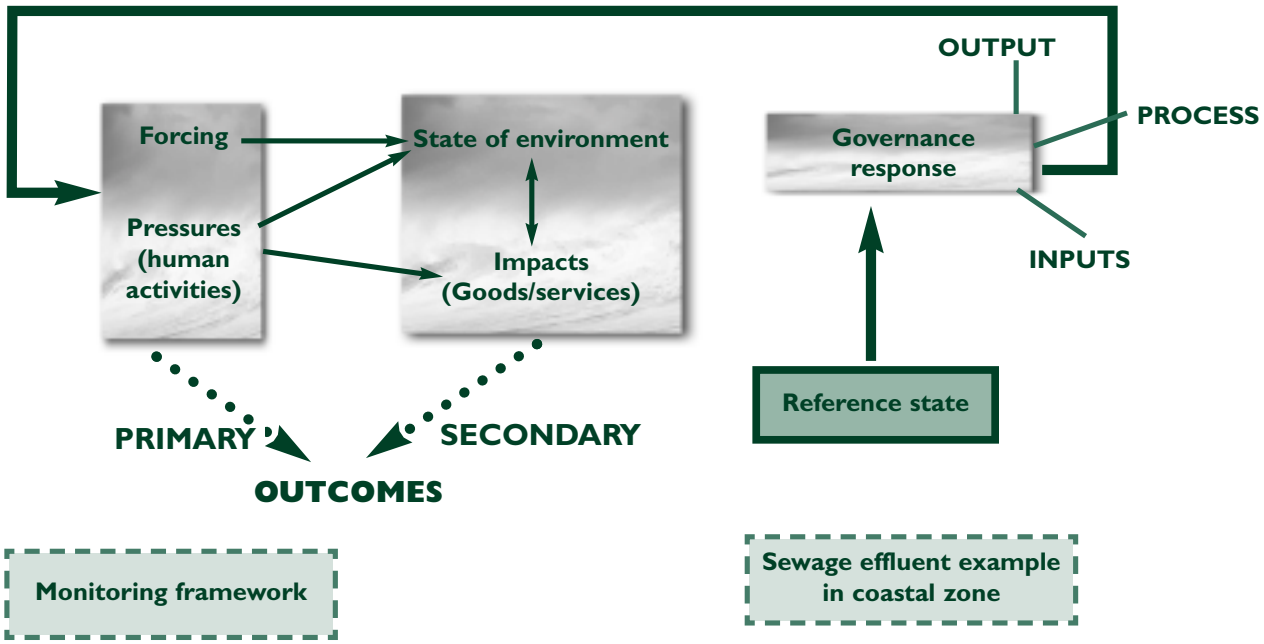
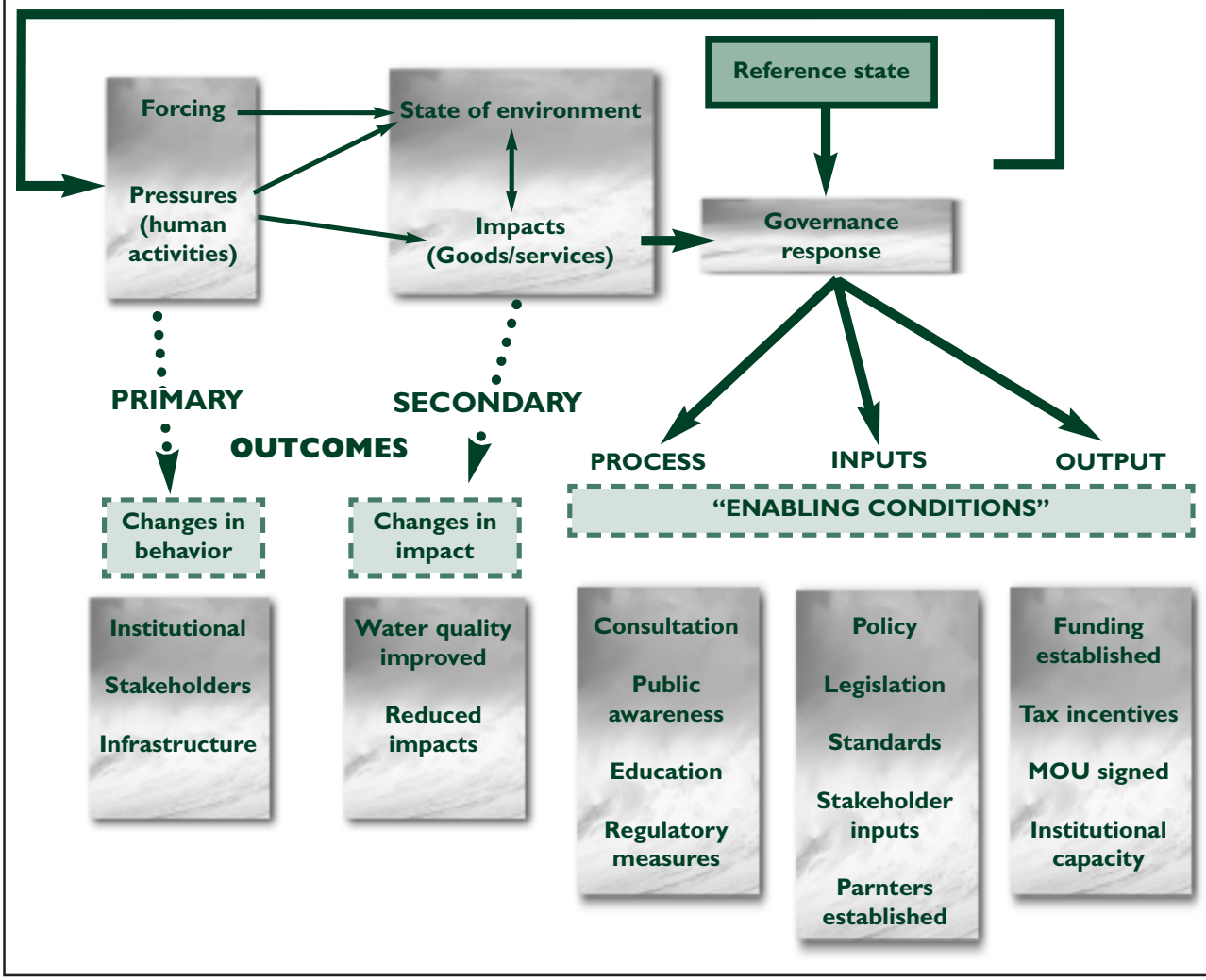


Figure 2 *Revised indicator framework*



ditions) and the reference state (desired conditions), then management intervention is warranted. The reference state may be based on measurements of an ecosystem similar to the one under study, but lacking in the pressures of human activities, or it may be based on an earlier, less developed state of the environment under study.

Impacts on Goods and Services Changes in the marine environment can provide opportunities for, and create impacts on, the provision of goods and services from the sea. An opportunity for increased fishing could result from a moderate increase in the nutrient loading to an estuary for example. On the other hand, severe nutrient loading could alter the species composition of the fish community and deplete oxygen in deeper water layers, leading to a decline in desirable fish species. Bacterial contamination or contamination from toxic or tainting substances can have a negative impact on the production of shellfish from coastal waters, and on the aesthetics of the beach areas for recreation and tourism. Indicators of impacts and opportunities often have a social or economic component to their measurement.

The production of goods and services from the sea can also be impacted directly by other human uses, even when there is no change in the state of the environment. This can happen when two type of marine use share the same space, as for example, when the siting of aquaculture cages interferes with marine transportation, recreational or fishery uses. The impact indicators need to be broad enough to describe conflicts that may occur among different uses in the coastal zone.

Governance Response Once the state of environment has deviated from the reference state, or there are serious impacts upon coastal goods and services, a governance response is elicited. This is a series of interventions intended to correct the impact or move the environmental state in the direction of the reference state. It is useful to subdivide the response into 'process', 'inputs' and 'outputs' so that an 'audit trail' of interventions can be followed later when it is important to link outcomes to interventions. The 'governance response' indicators, taken together, are not to be thought of as outcomes, but merely as "enabling conditions" which will lead to outcomes.

Governance response 'Process' indicators describe the process by which interventions take place. They may document public awareness and behavioral education programs that sensitize stakeholders to the coastal management issues and encourage voluntary changes in behaviour. They may describe consultative processes to determine public opinion about desired outcomes, and they may include strategies for regulatory intervention.

'Governance response 'Input' indicators refer to governance activities which prepare the way for action. The planning stage of management is included here. Stakeholder inputs and socio-economic studies may be used to determine desired outcomes, and key partners are identified. Vision and mandate are established. Policy is developed, legislation enacted and environmental standards are proposed to provide the intervention tools.

Governance response 'Output' indicators show progress in the way that governance is responding in terms of structural change. As a result of governance inputs, funding may be established and tax incentives devised to encourage behavioral changes in human activities. Intervention partners may sign Memoranda Of Understanding. Institutional capacity may be developed to increase science inputs, monitoring functions and enforcement capabilities. In terms of monitoring progress in ICM, it must be remembered that the activities described by 'governance response' output indicators is still only "enabling", - it hasn't yet resulted in significant change in human behavior.

Primary Outcomes It is in the primary outcome indicators where actual changes in behavior is documented. These may be changes in institutional behavior. An example would be interdepartmental meetings or the designation of liaison officers to coordinate sectoral activities in solving the sewage problem. Behavioral change may be seen in stakeholders, for example in improved compliance with guidelines for the use of sewage facilities and the appropriate means for disposal of toxic materials. Change might also be indicated in infrastructure, for example as increased connection of residents to existing sewage systems, or in the construction of additional sewage systems. The 'primary outcome' indicators provide a measure of the sustainability of the ICM process because they measure changes in the behavior of society.

Secondary Outcomes Secondary outcomes are improvements in health of the environment or reductions in the impacts on marine goods and services that

were the objective of the ICM process in the first place. In the sewage example, improved water quality could be indicated by "a 50% reduction in nutrient loading to coastal waters over 5 years". A reduction in the impacts of sewage on the marine environment could refer to a secondary outcome: "the frequency of algal bloom events has been reduced to zero".

Box 1

In summary, the indicator framework allows us to monitor the various components in the ICM process. It forces us to consider:

- The marine environment,
- The human activities which affect it,
- The forcing factors which are beyond management control but which can alter outcomes,
- The goods and services derived from the coast,
- The 'audit trail' of management interventions that link cause and effect,
- The behavioral outcomes which contribute to sustainability,
- The achievement of targeted outcomes that we identified as our key objective in the first place.

WORKING GROUP REPORTS

Environmental Indicators

Chair: Jack Mathias

Participants: Camille Mageau, Danielle Tesch, Robert Christian, Raj Murthy, Yumiko Kura, Dulcie Linton, Nicollette Dimetriades, Anthony Forbes, Keith Thompson, Stephen Olsen

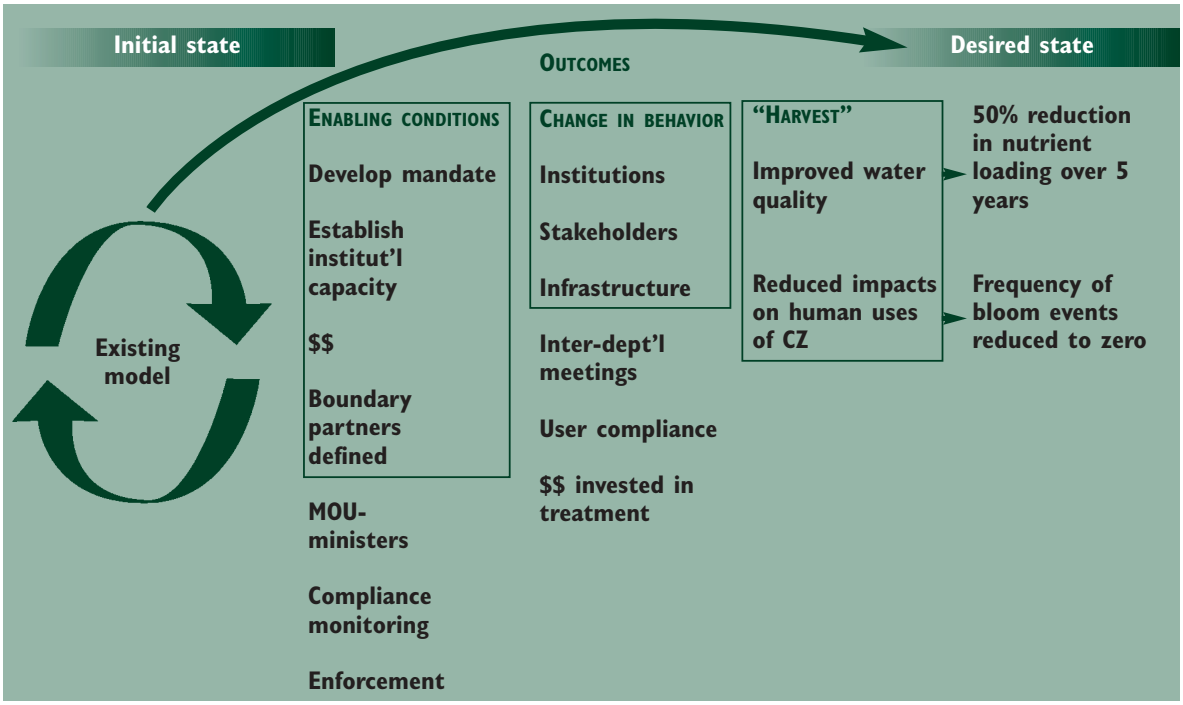
Over two days of intense discussion the environmental group developed and modified a model (framework) for the use of indicators in integrated coastal management. One of the essential components of this model includes a provision for natural variability within the system and variability experienced from natural hazards (e.g., hurricanes, surge flooding, etc.). One of the key motivations behind the development of the framework was to make the model comprehensible for managers and other people measuring ICM. The outcomes, after much discussion within the group, were modeled after Stephen Olsen's work with first, second, third, and fourth order outcomes. In order to make these concepts more comprehensible the outcomes were not called "first," "second," "third," but were given more descriptive phrases ("enabling conditions," "change in behavior," and "harvest," respectively) (see Figure 1).

In the scheme, components of the ICM cycle, namely, inputs, processes, and outputs, are considered as part of the policy response, acting on the driving forces to modify human pressures on the environment. Following the discussion, the scheme has been modified (Figure 3) to reflect the discussion held on the governance performance indicators in relation to different orders of outcomes for different stages of the ICM cycle.

On the third day, the group focused on creating a parsimonious list of environmental indicators. The use environmental indicators have a long history and extensive lists of such indicators have been well developed. Creating a parsimonious list proved to be a challenge, which started with analyzing the "suggested parsimonious list" found in the background document. After consideration, the working group did not feel that the sectoral segregation of environmental indicators was appropriate. The group aggregated the environmental indicators into useful indices with the intention that they be integrative and credible, i.e., water quality index, biocumulative index, aesthetic index, human health index, species diversity and trophic structure, habitat inventory (integrity and availability), and nutrient cycling (see matrix in Table 1). The matrix is only in draft format at this time.

Throughout the three days of discussion the group used coastal water quality as an example to work out the details of the model and the environmental indicators matrix. Work ahead includes finishing the matrix and thinking about how to incorporate weights to give further guidance to managers in choosing the appropriate indicator to use.

Figure 3 *Indicator framework focused on outcomes*



INDEX	SECTOR		
	Fisheries	Tourism	Aquaculture
Water Quality Index			
– Seafood quality	•		•
– Contamination	•		•
– Turbidity		•	
– Eutrophication		•	•
Biocumulative Index, etc.			

Table 1 *Example of matrix for environment indicators*

Socioeconomic Indicators

Chair: Robert Bowen

Participants: Miriam Balgos, Ralph Cantral, M.J. Comfort, Carol Ann Forthman, Marea Hatziolos, Saa Kabuta, Marie Lagier, Bernice McLean, Liana Talaue-McManus, Tavis Potts, David Terkla, Herb Vandermeulen.

The working group on socioeconomic indicators focussed largely on a set of preliminary socio-economic indicators drawn from the background report, including other sources such as the World Bank, the OECD and the UN. The working group began by identifying key classes of socioeconomic indicators and prioritizing additional indicators relevant to integrated coastal management within the scope of the frameworks discussed during the workshop. The relevance of the chosen indicators was then "tested" by applying them to a key issue in coastal regions, coastal tourism and a final list was drawn up (see below).

As a final exercise, the working group discussed criteria by which to distinguish whether the chosen indicator classes were either critically important or conceptually important. Initial criteria included: i) Level (global, regional, national) ii) Importance; iii) Availability (accuracy, validity, usefulness); iv) Cost Effectiveness; v) Ease of use; and vi) Linkage value (synergy with other indicator types). A draft scheme was developed as a framework to incorporate the socioeconomic indicators, based on frameworks presented by the environmental and governance working groups.

The next steps identified by the working group included:

- Dissemination of a worksheet listing the indicators and their responsiveness to the above-mentioned cri-

teria to working group participants for review and assessment;
- Description of the worksheet (including possible illustration);
- Further refinement of the core list of socioeconomic indicators; and
- Clarification of indicator criteria definitions.

The results of the working group discussions will also contribute to current discussions of indicators within the Global Ocean Observing System (GOOS).

Socioeconomic State Characteristics

Population Dynamics
- Resident Population within 100 km of Coast/within Watershed
- Population Change in Coastal Areas
- Population in Coastal High Hazard Areas
- Population by Age Structure
- "Informal" Population
- Urban/Rural Population

Coastal Zone Extent
- Land Use/Land Cover Patterns in Coastal Zone
- Coastal Zoning Patterns (Including Offshore Use Zones)

Economic Conditions
- Gross Domestic Product (GDP)
- Annual Growth in GDP
- Environmentally Adjusted Net Domestic Product
- Per capita Income
- Patterns of Income Distribution
- Employment Patterns and Trends
- Patterns and Trends in Industrial Production
- Economic Value of and Employment in Coastal Industry Sectors
- Reliance on external financial support (donor funding)

Social Conditions and Cultural Traditions
- % of Population with Access to Potable Water
- Educational Attainment
- National Disease Burden
- % of Population with Internet Access
- Infant Mortality
- Cultural Stability/Integrity
- "Cultural Spatial Mapping"

Additional
- Rural non-agricultural unemployment
- Food security
- Patterns of Capital ownership
- Land tenure security (distribution of ownership within the coastal area) / (% of people owning more than one ha of land)
- Property values
- Income/wealth distribution
- Population density
- Per capita consumption of energy (kw/hrs per capita)
- Access to public services

Pressure Characteristics

Development Pressure/Capital Construction
- % Altered land w/ 100 km of Coast
- %/Miles of Artificial Coast (jetties, seawalls, groins, breakwaters)
- #/Trends of Coastal Building Permits
- % of Impermeable Surfaces in Coastal Zone
- Coastal Dredging (Location/Cost)
- Public Access Points/km of Coastline
- Coastal Fill acres/year
- Freshwater Dams - Location, capacity
- % water-dependent use industry / coastal industry
- Peak seasonal population

Habitat Change/Ecological Value
- Service Value of Coastal Habitat
- Value of Manufactured Products from Coastal Habitats
- Value of Pharmaceutical and Biotechnology from Coastal Habitats
- Non-Use Values of Coastal Habitat (Bequest/Existence/Option)
- Marine Protected Areas - Location, Size
- % Public Ownership of Coastal Watershed

Contaminant Introduction
- % of Population Served by Wastewater Treatment (P/S/T)
- Functioning/Age of Wastewater Facilities
- Industrial Inputs of Persistent Organic Pollutants (POPS)/Metals
- Fertilizer Use in Coastal Watershed
- Pesticide Use in Coastal Watershed
- Non-Agricultural Nutrient Inputs
- Non-Industrial Inputs of POPs/Metals

– Vessel Introduction of Nutrients, POPs, Metals
– Oil Entering Environment from All Sources

Resource Extraction Activities
- Oil Spills from Extraction/Transportation Activities
- Coastal Oil/Gas Permits and Extracted Amounts
- Coastal Renewable Energy - Location, Production Capacity
- Marine Mining Permits and Extracted Amounts
- Tar balls
- Level/Value of Commercial Landings by Harvest Area
- Commercial Catch/Unit Effort
- Structure of Commercial Fleet–National/International
- Levels of Commercial By-Catch
- Level of government financial support (Subsidy, loans guarantees tax credits)
- Artisanal Fishing Effort
- Number/Value of Recreational Fishing Days
- Commercial Charter Boats - Number, Capacity
- Seafood Consumption Patterns
- Seafood Import/Export Quantity, Value by Species
- Change in value of coastal Ornamentals

Human Uses/Activities
- Coastal Watershed Aquaculture (Number, Location, Species Annual Yield)
- Number of Coastal Tourists (Seasonal)
- Percentage domestic Tourists
- International Coastal Tourist Arrivals
- Value of Tourism and Employment in Coastal Tourism Sector (National/Coastal)
- Distribution of Coastal Tourism Benefit (to state characteristic?)
- Coastal Tour Vessels
- Proportion of Coastal Ecotourism/Coastal Tourism
- Number/Attendance Recreational Bathing Beaches
- Number of Recreational Boats/Boaters in Coastal Zone
- Number/Capacity of Recreational Pump-out Facilities
- Number/Size of Recreational Marinas/Commercial Ports and Harbors
- Capacity of Commercial Ports and Harbors
- Number of Shipping Vessels Entering/Transiting Coastal Waters
- Restrictions on human activity on an arial basis (Marine Protected Area or closure as well as restrictions due to extractive/industrial use)

Socio-Economic Impacts and Outcomes of Coastal System Change

Infrastructure Development Pressure/Capital Construction
- Cost of Coastal Flooding and Coastal Hazards/Savings Provided by Coastal Habitat
- Infrastructure Costs Associated w/ Development Driven Coastal Erosion
- Dredging Costs/Savings Driven by Sediment Contamination/Mitigation
- Coastal Clean-up Costs other than Dredging Costs
- Beach Replenishment Costs
- Infrastructure development

Habitat Change/Ecological Value
- Social Costs of Invasive Species
- Changes to Non-Use Values of Coastal Habitats (Bequest/Existence/Option)
- Service Value changes from Habitat alteration

Contaminant Introduction
- % Coastal Harvesting Areas Under Environmental Restrictions
- Aquaculture

Resource Extraction Activities
- Value changes to Seafood Due to Chemical Contamination
- Value changes to Seafood Lost Due to Pathogenic/Toxic Contamination
- Value changes to Seafood Lost to Factors other than Overexploitation

Human Uses/Activities
- Marine-vectored Disease (Cases/Outbreaks/Disability Adjusted Life Years)
- Number of Beach Closings
- Costs of Beach Closing Days
- Change in value of Coastal Recreation Days
- Touristic changes (#/people/value) Due to Coastal Alteration
- Changes to Coastal Property Values
- Socio-Cultural Conditions
- Change in cultural traditions resulting in social dislocation
- Change in livelihood
- Change in user conflict

Governance Performance Indicators

Chair: Charles Ehler

Participants: Stefano Belfiore, Ralph Cantral, Patrick Christie, Biliana Cicin-Sain, Alison Evans, Jordi Galofre, Marea Hatziolos, Irene Kamau, Yumiko Kura, Francisco Montoya, Stephen Olsen

The working group participants discussed different indicator frameworks of possible use to assess the performance of governance in ICM:

- In the Pressure-State-Response framework developed by OECD governance performance indicators would fit into the Response component. But the framework appeared of limited use to ICM given its focus on the environment.
- The revised Diving forces-Pressure-State-Impacts-Response framework, adopted by the European Environment Agency (EEA) and other international organizations, provides a better context to integrate different types of indicators, given the possibility to take into account not only environmental impacts but also socioeconomic impacts resulting from changes in the state of coastal ecosystems.
- More focused on governance performance, the Input-Output-Outcome-Impact framework of the World Bank can provide a setting in which to track progress in ICM through the use of two fundamental types of indicators: process indicators and outcome indicators.
- A framework developed by the Coastal Resources Center (CRC) and centered on different orders of subsequent outcomes over time can yet provide further insight on the sequence of actions to be assessed in the ICM cycle, namely, (a) enabling conditions, (b) changes in behavior, (c) short-term outcomes, and (d) long-term outcomes.

While the participants agreed that the focus of headline indicators to measure governance performance should be on outcomes rather than on processes, there was no agreement on which framework would best facilitate such measurement. The limitations and uncertainties in the causal linkages between specific ICM efforts and related outcomes suggested that further discussion is needed to identify the appropriate framework to measure the progress of ICM at different stages of development (Figure 4). In particular, the difficulty of ICM programs and projects in demonstrating their environmental and socioeconomic benefits compounds today with competing funding requests to international donors from traditional mainstream sectors. The participants felt that it is therefore important to link ICM efforts to the main issues on the world's agenda, such as poverty alleviation and reduction of pollution from land-based activities.

The working group developed a series of classes of indicators for different functions of ICM. Time limitations did not allow the participants to agree on a short list of indicators organized per ICM stages. However, the participants felt that governance performance indicators should be able to measure milestones/thresholds demonstrating the achievement of a certain stage in the ICM process and should be action-oriented, suggesting which actions managers should take to advance ICM. The choice of indicators would ultimately depend on the environmental, socioeconomic, and governance context in which they are used as well as on the specific goals and objectives of ICM programs and projects. It should be possible, however, to identify a "menu" of indicators from which managers could choose to self-assess their efforts. In this regard, the list of indicators represented in Table 2 was suggested.

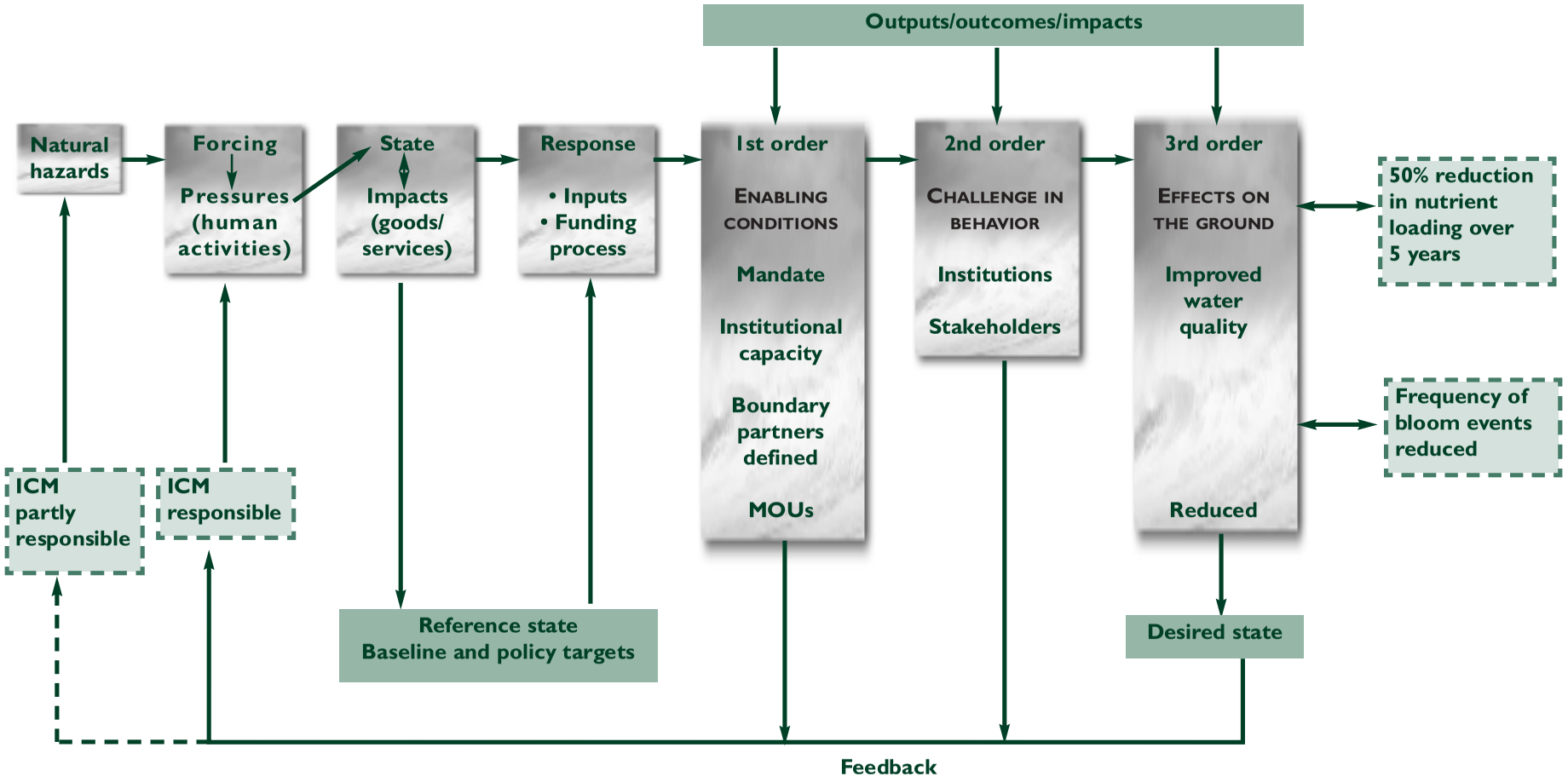


Figure 4 *General model for the use of indicators in integrated coastal management (using the example of sewage effluent in the coastal zone)*

Table 2 *Examples of governance performance indicators*

Phase (stage)	Feature of governance	Indicators of output or outcome
Initiation	Authority	Enabling legislation enacted
		Executive mandate issued
		Authority for national and sub-national bodies identified clearly
		Roles and responsibilities for ICM among levels of government clearly identified
		Soft and hard legal instruments identified
		Overlaps and gaps among institutional mandates clearly identified
	Leadership	Political support obtained and maintained
		Agency leadership identified and developed
		Leaders of constituency groups identified and developed
	Visioning	Consensus built for common vision [philosophy]
		Linkage of ICM with national development, economic development and environmental goals
	Institutional capacity	Interagency steering/coordination group established
		Scientific/user advisory groups established
		Initial partnerships formed
		Training courses for public officials held
		Authority and roles for different levels of government and stakeholders identified
		Rights and responsibilities ("rules of the game") are clearly defined
		Consistency among actions at various levels of government (national, regional, local) ensured
		Inter-agency process and authority defined clearly
		Coordination among ICM projects and investment ensured
	Human resource development	Development of human resources to plan, implement, monitor, and evaluate ICM
		Identification of necessary leadership skills and broadcast of these expectations
	Tenure	Development of appropriate tenure relationships to support ICM and protect public domain
	Empowerment	Local stakeholders have influence and control over ICM regime that has legal basis
	Financial resources management	Scaling of financial resources is appropriate to institutional capacity
		Financial contributions to ICM are effectively coordinated
Planning	Planning capacity	Adequate resources for planning allocated
		Appropriate staff hired, trained, and maintained
		Baseline studies completed
		Problems identified, analyzed and ranked
		Management boundaries defined
		Clear and realistic goals/targets identified and ranked
		Measurable management objectives specified
		Alternative management strategies identified and analyzed
		Costs/benefits of alternative management strategies analyzed
		Selection criteria for management strategies specified
		Ability to be adaptive and react to unpredicted change (e.g., climate change) established
		Ability to be predictive, anticipatory established
		Collaborative, participatory and transparent planning processes adopted
		Stakeholders actively participate in regular ICM planning meetings
		Access to public coastal resources assured
	Information management capacity	Adaptive information management system established
		Performance indicators established
		Information is effectively and appropriately organized, managed, and disseminated
		Public access to information is assured
		Verifiable information is used to determine management issues

Table 2 (cont.)

Phase (stage)	Feature of governance	Indicator of output or outcome
	Public participation	Public awareness program initiated
		Increased awareness of coastal issues
		Effective stakeholder participation in all phases of ICM
		Stakeholders satisfied with degree of participation
		Stakeholders have access to information related to ICM
		Assurance that "unheard voices" are taken into consideration
Adoption	Formalization and support	Legitimate authority(s) agree to adopt plan of action
		ICM program integrated into national environmental management & sustainable development programs
		Plan of action endorsed by constituencies and users
		Stakeholders actively seek resources to implement plan of action
		Long-term financial support for all elements of ICM (e.g., monitoring) ensured
Implementation	Implementation capacity	Clear authority provided to write/enforce regulations to change behavior
		Clear authority to provide economic and economic incentives to change behavior
		Appropriate funding available for implementation activities
		Socially beneficial changes in user and institutional behavior as a result of management actions
		Diverse activities among institutions and projects are effectively coordinated
	Enforcement capacity	Appropriate compliance monitoring program in place
		Appropriate penalties assessed and collected for non-compliance
	Conflict resolution	Mechanisms for resolution of conflicts among agencies identified and implemented
		Conflicts among users resolved/mitigated
		Future of uses and conflicts anticipated
	Decision making	Definitive decisions taken
		Decision makers held accountable for results
Environmental and socioeconomic outcomes	Coastal & Marine Environmental Quality	Improvements in water quality over a range of physical, biological and chemical parameters
		Increases in percentage of coastline suitable for bathing and recreation
		Reduction of human diseases associated with water quality
		Socioeconomic benefits from increased tourism and recreation
	Coastal Hazards	Relocation of people and structures from high-risk areas
		Reduction of human, environmental, and socioeconomic losses due to coastal hazards
	Coastal Development	Reduction of conflicts over coastal use
		Socioeconomic benefits (jobs, income, revenues) from increased coastal activities
	Biodiversity/Habitat	Reduction in percentage of endangered and threatened species
		Improvements in structure and function of coastal and marine ecosystems
		Socioeconomic benefits from coastal and marine protected areas
	Fisheries	Reduction of damaging practices (by-catch) and equipment
		Recovery of fish stocks
		Increase in fish productivity
		Socioeconomic benefits from sustainable fisheries
Monitoring and evaluation	Monitoring capacity	Appropriate management performance monitoring is operational
		Appropriate users and communities involved in monitoring
		Monitoring and evaluation of social, economic and bio-physical context is operational
		Advanced monitoring tools employed when appropriate, available, and fiscally possible
Adaptation and reformulation	Evaluation capacity	Outcome indicators used to evaluate performance
		Evaluation of success/failure of management action fed back to planning
		Evaluation results used to reallocate resources
		Evaluation results used to change goals, objectives, management strategies, and desired outcomes

PROBLEMS FACING THE USE OF INDICATORS IN ICM

The workshop also considered problems and shortfalls in the use of indicators. These problems are related to the "misuse" of indicators, a poorly managed process of development, and using indicators for the wrong reasons. The opposite is true when indicators are a part of an established "toolbox" with an adequate process and information. Effective use of indicators should address these concerns.

- Reporting at higher scales can conceal locally relevant information integral to the issue at hand.
- Indicators can drive the process (as opposed to remaining a tool within the process).
- Portrayal as a completely value free or context indifferent? (Indicators are by their nature and construction a value based measurement, as evidenced by the selection of a framework and appropriate indicators).
- Can be held responsible for processes or outcomes that one has no control over.
- Can result in unrealistic expectations for results.
- Results can be assessed without consideration of spatial / temporal context.
- Tend not to be adaptive.
- Constrains local variation.
- Indicators set by donors. Is generally a top down approach? There is a need for more consultative mechanisms.
- Indicators can be easily politicized.
- An inadequate ordering framework can lead to confusion over how to express the indicators for a particular issue.
- Can stymie innovation (when don't fit indicators).
- Can limit public participation – setting of indicators, monitoring, sense making! Can be desempowering.
- Indicators can be expensive to implement (estimates of up to 10% of program costs). It can impact who is a player in coastal management, tending to favor large actors (especially in the case of certification).
- Overaggregation – can lead to misleading assumptions and indecipherable messages. It can also disguise meaningful local trends. E.g. Use of GDP as an aggregate or Biomass in fisheries. Conversely measuring too few indicators can miss important parts of the issue / trend.
- Indicators can fall into the trap of trying to measure what is measurable as opposed to measuring what is important. E.g., forest cover instead of ecosystem health, money earned rather than quality of life, etc.
- Dependence on a false model or false relationships amongst the indicators. Also, particular to the PSR model, false assumptions can be made about the linear causality theorem, i.e., the pressure causes the state which in turn results in a response.
- Indicators can be deliberately falsified (especially in highly political instances), e.g., employment rate, global fisheries catches.
- Indicators can be "hijacked" by operators with their own agenda.
- Indicators can lead to overconfidence – we know what we are doing or what we are doing is working, when in fact the indicators could be faulty.
- A major problem is that the use context of indicators can be distorted. They do not aim to be a "solve all" method rather an approach to explicitly acknowledge and investigate the important components of an issue related to sustainability. They are one tool in the toolbox and do not replace sophisticated quantitative and qualitative approaches.
- Incompleteness – indicators are not the real system; they are valued components of our interpretation of reality. Because of this fact, they may miss many subtleties, relationships, feedback, and other important considerations.

ATTACHMENT A - WORKSHOP PROGRAM

Monday, April 29, 2002

09:00-09:30
Welcome and opening
Camille Mageau, Department of Fisheries and Oceans, Canada
Julian Barbiere, Intergovernmental Oceanographic Commission

09:30-10:45
Session I—Critical Overview and Comparison of Different Systems of Indicators
Chair: Biliana Cicin-Sain, Center for the Study of Marine Policy, University of Delaware
Robert Bowen, University of Massachusetts
Socioeconomic Indicators
Jake Rice, Department of Fisheries and Oceans, Canada
Environmental Health Indicators
Charles Ehler, National Oceanic and Atmospheric Administration
Governance Indicators

11:15-13:00
Session II—Case Studies from International Programs for the Development of Indicators
Chair: Raj Murthy, Canada Centre for Inland Waters
Keith Thompson, Dalhousie University
The Coastal Global Ocean Observing System
Robert Christian, East Carolina University
The Coastal Global Terrestrial Observation System
Dulcie Linton, University of West Indies
Biological Indicators in the Caribbean Coastal Zone and Their Role in Integrated Coastal Management
Luncheon Speech
Arthur Hanson, International Institute for Sustainable Development
Measuring Progress Toward Sustainable Development

14:00-16:00
Working Groups
a) Socioeconomic Indicators—Chair: Robert Bowen
b) Environmental Indicators—Chair: Jack Mathias
c) Governance Indicators—Chair: Charles Ehler

16:30-18:00
Plenary Session
Chair: Robert Christian, East Carolina University

19:00
Dinner, sponsored by Department of Fisheries and Oceans, Canada

Tuesday, April 30, 2002

09:00-10:30
Session III—Case Studies on the Application of Coastal Management Indicators
Chair: Stephen Olsen, Coastal Resources Center
Liana Talaue-McManus, University of the Philippines and University of Miami
Biophysical and Socioeconomic Basis of Coastal Typologies
Saa H. Kabuta, The National Institute for Coastal And Marine Management, The Netherlands
Ecological Performance Indicators in the North Sea Area
Patrick Christie, University of Washington
Indicators to Measure Sustainability of Integrated Coastal Management Programs

11:00-13:00
Session IV—Assessing Performance of Efforts in Integrated Coastal Management
Chair: Marea Hatziolos, World Bank
Terry Smutylo, International Development Research Centre
Indicators for Mapping Behavioral Change in Natural Resource Management Programs
Marea Hatziolos, World Bank
Environmental Performance Indicators at the Project and Program Level
Stephen Olsen, Coastal Resources Center
Frameworks and Indicators for Assessing Progress in ICM Initiatives

14:00-16:00

Breakout Sessions

a) Socioeconomic Indicators—Chair: Robert Bowen
b) Environmental Indicators—Chair: Jack Mathias
c) Governance Indicators—Chair: Charles Ehler

Wednesday, May 1, 2002

16:30-18:00

Plenary Session

Chair: Patrick Christie, University of Washington

09:00-10:30

Working Groups

a) Socioeconomic Indicators—Chair: Robert Bowen
b) Environmental Indicators—Chair: Jack Mathias
c) Governance Indicators—Chair: Charles Ehler

11:00-13:00

Plenary Session

Chair: Charles Ehler, National Oceanic and Atmospheric Administration

14:00-15:00

Concluding Session

Co-chairs: Camille Mageau, Department of Fisheries and Oceans, Canada and Julian Barbiere, Intergovernmental Oceanographic Commission

ATTACHMENT B – LIST OF PARTICIPANTS

Ms. Miriam Balgos
Center for the Study of Marine Policy
College of Marine Studies
University of Delaware
Newark, DE 19716
Tel: +1 (302) 831-8086
Fax: +1 (302) 831-3668
Email: mbalgos@udel.edu

Mr. Julian Barbiere
Programme Specialist
ICAM and Regional Programmes
Intergovernmental Oceanographic Commission (IOC)
UNESCO
1, rue Miollis
75732 Paris Cedex 15, France
Tel: +33 1 45 68 40 45
Fax: +33 1 45 68 58 12
Email: j.barbieregunesco.org

Mr. Stefano Belfiore
Center for the Study of Marine Policy
College of Marine Studies
University of Delaware
Newark, DE 19716
Tel: +1 (302) 831-8086
Fax: +1 (302) 831-3668
Email: sbelf@udel.edu

Dr. Robert E. Bowen
Associate Professor
Department
University of Massachusetts
Boston 100 Morrissey Blvd.
Boston, MA 02125-3393
Tel: +1 (617) 287-7443
Email: bob.bowen@umb.edu

Mr. Ralph Cantral
Office of Ocean and Coastal Resource Management
Environmental, Coastal and Ocean Sciences
NOAA Ocean Service, OCRM
1305 East West Highway
Silver Spring, Maryland 2 09 1 0
Office Tel: +1 (301) 713-3155
Fax: +1 (301) 713-4012
Email: ralph.cantralgnoaa.gov

Dr. Robert Christian
Professor
Biology Department
East Carolina University
Greenville, NC 27858
Tel: +1 (252) 328-1835
Fax: +1 (252) 328-4178
Email: christianr@mail.ecu.edu

Dr. Patrick Christie
School of Marine Affairs
University of Washington
3707 Brooklyn Ave., North
Seattle WA 98105
Email: patrickc@u.washington.edu

Dr. Biliana Cicin-Sain
Director
Center for the Study of Marine Policy
Graduate College of Marine Studies
University of Delaware
Newark, DE 19716-3501
Tel: +1 (302) 831-8086
Fax: + 1 (302) 83 1-3668
Email: bcs@udel.edu

Ms. M.J. Comfort
Marine Protected Areas National Coordinator
Fisheries and Oceans Canada
Marine Ecosystems Conservation Branch
200 Kent Street
Ottawa, Ontario
Canada KIA OE6
Tel: +1 (613) 991-5935
Email: comfortm@dfo-mpo.gc.ca

Mr. Charles Eher
Director
International Program Office
NOAA/NOS
1305 East West Highway, room 13442
Silver Spring, MD 20910
Tel: +1 (301) 713-3080 ext. 159
Fax: +1 (301) 713-4263
Cell: + 1 (301) 536-1619
Email: Charles.Ehler@noaa.gov

Ms. Alison Evans
ICPP
Faculty of Architecture
Dalhousie University
Halifax, Nova Scotia
Canada B3H 3J5
Tel. +1 (902) 494-3007
Email: Alison.Evans@Dal.Ca

Dr. Anthony Forbes
Professor
Marine & Estuarine Research
School of Life & Environmental Sciences
University of Natal
Durban 404 1, South Africa
Tel./Fax: +27 (31) 260-3183
Cell: 082 451 8078
Email: forbesa@biology.und.ac.za

Dr. Carol Ann Forthman
Environmental Sciences Institute
Florida A&M University
Tallahassee, Florida 32307
Tel: +1 (850) 561-2128
Fax: +1 (850) 561-2248
Email: carol.forthman@famu.edu

Mr. Jordi Galofre
Center for the Study of Marine Policy
College of Marine Studies
University of Delaware
Newark, DE 19716
Tel: + 1 (302) 831-8086
Fax: + 1 (302) 831-3668
Email: gjgalofre@cgaol.coni/jgalofre@state.de.us

Dr. Arthur Hanson
Ministerial Ocean Ambassador, Canada
DFO and International Institute for Sustainable Development
161 Portage Avenue East, 6 Floor
Winnipeg, Manitoba
Canada R3B OY4
Tel.: +1 (204) 958-7717
Fax: +1 (204) 958-7710
Email: ajhanson@iisd.ca

Dr. Marea Hatziolos
Senior Coastal and Marine Specialist
Environment Department
MC5-512
The World Bank 1818 H St., NW
Washington, DC 20433
Tel: +1 (202) 473-1061
Fax: +1 (202) 522-0367
Email: MhatziolosO@lworldbank.org

Ms. Marie Lagier
Project Officer
Global Marine Programme
IUCN -The World Conservation Union
Canada Office
555 boul. Rene-Levesque Ouest, Bureau 500
Montreal, Quebec, H2Z 1 B 1, Canada
Tel: +1 (514) 287-9704 ext. 359
Fax: +1 (514) 287-9687
Email: lagier@iucn.ca

Dr. Saa H. Kabuta
RIKZ, Coastal Zone Management Centre
National Institute for Coastal
and Marine Management, Ministry of
Public Works, Transport and Water Management
P.O. Box 2097
2500 EX The Hague
The Netherlands
Email: S.H.Kabuta@rikz.rws.min@enw.nl

Dr. Irene Kamau
WWF Tanzania Progranune Office
Plot No.350, Regent Estate Mikocheni
P.O. Box 63117
Dar-es Salaam, Tanzania
Tel: +255 (22) 25346
Fax: +255(22)2775535
Email: wftpo@raha.corri/inkamau@raha.com
mlydia@raha.com

Ms. Yumiko Kura
World Resources Institute
10 G Street, NE (Suite 800)
Washington, DC 20002 USA
Tel: +1 (202) 729-7783
Email: yumiko@wri.org

Ms. Dulcie Linton
Data Manager
Caribbean Coastal Data Centre (CCDC)
Centre for Marine Sciences
University of West Indies
Kingston 7, Jamaica, West Indies
Email: dmlinton@uwimona.edu.jm

Dr. Camille Mageau
Director
Fisheries and Oceans Canada
Marine Ecosystems Conservation Branch
200 Kent Street
Ottawa, Ontario
Canada KIA OE6
Tel: +1 (613) 991-1285
Fax: +1 (613) 993-6414
Email: mageauc@dfo-mpo.gc.ca

Dr. Jack Mathias
Head
Oceans Office, Oceans Division
Fisheries and Oceans Canada
Oceans Program
501 University Crescent
Winnipeg, Manitoba
Canada R3T 2N6
Tel: +1 (204) 983-5155
Fax: +1 (204) 984-2403
Email: mathiasj@dfo-mpo.gc.ca

Mr. Vance McEachern
Chief
Risk Assessment and Management
Fisheries and Oceans Canada
Resource Management Directorate
200 Kent Street
Ottawa, Ontario
Canada K IA OE6
Tel: +1 (613) 993-0250
Email: mceachernv@dfo-mpo.gc.ca

Ms. Bernice McLean
Center for the Study of Marine Policy
College of Marine Studies
University of Delaware
Newark, DE 19716
Tel: +1 (302) 831-8086
Fax: +1 (302) 831-3668
Email: bmcl@udel.edu

Mr. Francisco Montoya
Jefe del Servicio de Costas en Tarragona
Dirección General de Costas
Ministerio de Medio Ambrente
Plaza Imperial Tariaco 4-4 planta
43005 Tarragona, Spain
Tel: +34 (977) 21 66 1
Fax: +34 (977) 23 05 63
Email: fmontoya@t.dgc.nima.es

Dr. Raj Murthy
Canada Centre for Inland Waters (CCIW)
PO Box 5050
Burlington, Ontario
Canada L7R 4A6
Email: raj.murthy@cciw.ca

Mr. Stephen Olsen
Director
Coastal Resources Center
Graduate School of
Oceanography
University of Rhode Island
Narragansett, RI 02882
Tel: +1 (401) 874-6501
Fax: + 1 (401) 789-4670
Email: Olsenuri@gsosunl.gso.uri.edu

Mr. Tavis Potts
Institute of Antarctic and Southern Ocean Studies
University of Tasmania
P. O. Box 252-77
Hobart, Tasmania
Australia 7001
Email: Tavis.Potts@utas.edu.au

Dr. Jake Rice
Director, Assessment and Peer Review
Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa, Ontario
Canada K IA OE6
Tel: +1 (613) 990-0288
Email: ricej@dfo-mpo.gc.ca

Dr. Terry Smutylo
Director, Evaluation
International Development Research Centre
P.O. Box 8500
Ottawa, Ontario
Canada K I G 3H9
Tel: +1 (613) 236-6163, ext. 2345
Fax: +1 (613) 563-0815
Email: Tsmutylo@idrc.ca

Dr. Liana Talaue-McManus
Division of Marine Affairs
Rosenstiel School of Marine
and Atmospheric Science
University of Miami
4600 Rickenbacker Causeway
Miami, Florida 33149
Tel: +1 (305) 361 4760
Fax: +1 (305) 361 4675
Email: lmcmanus@rsmas.miami.edu

Dr. David Terkla
Department of Economics
University of Massachusetts
Boston, MA 02125
Tel: +1 (617) 287-6511
Email: david.terkla@umb.edu

Ms. Danielle Tesch
Center for the Study of Marine Policy
College of Marine Studies
University of Delaware
Newark, DE 19716
Tel: +1 (302) 831-8086
Fax: +1 (302) 831-3668
Email: dmtesch@udel.edu

Dr. Michael Thomas
Division of Agricultural Sciences
Florida A&M University
Wahnish Way & Gamble Street
Tallahassee, Florida 32307
Tel: +1 (850) 599-3729
Email: n-tichael.thomas@famu.edu

Dr. Keith Thompson
Department of Oceano(yrapliy
Dalhousie Universitv
Halifax, Nova Scotia
Canada B3H 4J I
Tel: +1 (902) 494-3491
Fax: +1 (902) 494-2885
Email: Keith.Thompson@Dal.Ca

Dr. Herb Vandermeulen
DFO, Oceans Sector MECB
Marine Environmental Quality
200 Kent St., 12th floor
Ottawa Ontario, Canada KIA OE6
Tel: +1 (613) 990-0311
Email: vandermeulenh@dfo-mpo.gc.ca

APPENDIX II

IOC activities on indicators

Within the IOC Ocean Science Section, 5 major areas on indicators research are being implemented as follows:

IOC-WORLD BANK WORKING GROUP ON CORAL BLEACHING AND RELATED INDICATORS OF CORAL STRESS:

http://www.ioc.unesco.org/coralbleaching

Terms of Reference:

- Develop a more complete understanding of the molecular to cellular mechanisms underpinning coral bleaching and mortality of reef-building corals;
- Establish and test bioindicators of climate impacts and reef health. Develop appropriate bioindicator technologies at molecular, physiological and ecological scales;
- Pursue a greater understanding of the ecological mechanisms and outcomes of climate impacts on coral reefs; and
- Provide the basis for firmer estimates of the direction and rate of ecological changes to coral reef ecosystems under progressive climate change. Inherent in this last objective is to integrate the knowledge gained to create a sturdy knowledge basis for developing strategies for human societies to adapt to or mitigate climate driven changes.

The work of the Group will contribute to a five-year major Global Environment Facility (GEF) Targeted Research Project that has been launched by the World Bank and IOC/UNESCO. The GEF Project will address the gaps in our knowledge of factors determining vulnerability and resilience of coral reef ecosystems to a range of stressors, and the application of this knowledge to management.

Expected Outputs

The outputs anticipated from this series of targeted investigations will be:

1. A series of biomarkers such as:
   - **Molecular markers** which will rapidly and easily distinguish heat stress from other types of stresses (e.g. sedimentation, metal contamination, nutrient stress) on coral reefs.
   - **Cellular markers** that will enable users to accurately anticipate and monitor the advent of coral bleaching or recovery.
   - **Ecological markers** that will enable users to monitor impacts of coral bleaching and to project how the changes are likely to impact on local ecosystem function.
   - Genetic markers that will enable insight into the tolerance and resilience of communities of reef-building corals.
2. A more complete model of the mechanisms that trigger mass coral bleaching. This will enable better projections of the potential impact of climate change on coral reefs, and enable better prediction of the potential impacts to those human communities relying upon them as sustainable resources.

Documents and publications to date (see also the web site):

- Nature, Vol 45, 28 Feb 2002: "Reef under threat from 'bleaching' outbreak".
- R.P. Cooney, O. Pantos, M.D.Le-Tissier and J.C. Bythell: 'Comparison of the molecular microbiology of black band disease in corals between the Great Barrier Reef and Caribbean' (Marine and Freshwater Research, accepted).
- T.C. LaJeunesse, W.K.W. Loh, R.V. Woesik, O. Hoeg-Guldberg, G.W. Scmidt and W.K. Fitt: 'Symbiotic dinoflagellate (zoozanthellae) diversity occurring in Cnidarians from the Sourthern Great Barrier Reef compared with the Caribbean' (submitted, 2002).
- Initial Planning Meeting- Executive Summary, 2001.
- 'Understanding Coral Bleaching Across Four Oceans', Draft workplan, Dec 2001.
- Heron Island workshop, Great Barrier Reef: Research activities and seminar proceedings, Feb 2002.
- Puerto Morelos workshop, Mexico, executive summary, Sept 2002.

IOC WORKING GROUP ON BENTHIC INDICATORS:

http://ioc.unesco.org/benthicindicators/

Terms of Reference:

- Develop recommendations for a suite of globally applicable indicators and techniques to use in measuring the state ("health") of marine benthic communities;
- Demonstrate the effectiveness of these indicators through application in test data sets from selected coastal regions of the world; and
- Help to promote the use of these indicators, by as broad of a user community as possible, through the presentation of results of reports, publication, symposia, Internet-based web sites, or other effective forums.

Documents and publications to date:

- Journal Article: "Organic Carbon Content of Sediments as an Indicator of Stress in the Marine Benthos" by J. Hyland, Balthis, L. , Karakassis, I., Magni, P., Petrov, A., Shine, J., Vestergaard, O., and Warwick, R. (Submitted).
- An online web site database with synoptic data on macroinfaunal communities and environmental conditions from different coastal regions of the world are currently under development.
- IOC Technical Report no. 57 (2000): Benthic Indicator Group - results of initial planning meeting. Includes descriptions of benthos communities and environmental conditions in six coastal regions.

IOC/SCOR WORKING GROUP ON QUANTITATIVE ECOSYSTEM INDICATORS FOR FISHERIES MANAGEMENT:

http://www.ecosystemindicators.org/

Terms of Reference:

- To review the current state of knowledge in different marine and terrestrial disciplines relevant to the development of indicators for marine ecosystems (environmental, ecological and fisheries);
- To review theories (hierarchy, cascade…) and indicators that have been developed in terrestrial ecology and to assess their utility for marine ecosystems;
- To develop new indicators to study the functional role of species in ecosystems, exploitation and environment using output of multi-species models or available time series (fish catch statistics), and using satellites, and GIS (Geographic Information System);
- To apply these indicators in a comparative way to characterize ecosystem states, changes and functioning; and
- To assess the utility of these indicators for management purposes and for the sustainable utilization of renewable resources.

Outputs:

Reports of the first and the second meeting of the Working Group (available on the web site).

International Symposium: Quantitative Ecosystem Indicators for Fisheries Management, Paris, France, 31 March - 3 April 2004 (The papers presented orally at the Symposium and a small selection of papers based on poster presentations will be considered for publication in a special issue of the ICES Journal of Marine Science following peer review).

IOC/GLOBEC STUDY GROUP ON THE USE OF ENVIRONMENTAL INDICES IN THE MANAGEMENT OF PELAGIC FISH POPULATIONS:

http://www.pml.ac.uk/globec/main.htm

Terms of reference:

- To provide a comprehensive review of the use of environmental indices as hindcasting/nowcasting and forecasting tools of the fluctuations of pelagic fish in selected areas;
- To develop a scientific framework to understand the linkages between environmental variables and pelagic fish fluctuations, at relevant spatial and temporal scales;
- To investigate the requirements to incorporate environmental indices into stock assessment models and operational management procedures; and
- To propose a set of environmental variables of use in the management of pelagic fish populations to be included in local and global monitoring programmes.

Documents and Publications to date:
Report of the 1st meeting (2001):
http://www.pml.ac.uk/globec/Publications/Reports/IOC_SPACC_Report.pdf)

Report of the 2nd (Final) Meeting (Dec. 2002): In preparation

Journal Articles:

- A.Yatsu, T. Watanabe, M. Ishida, H. Sugisaki and L. Jacobson. Reproductive Success Variability of the Pacific Stocks of Japanese Sardine, Sardinops melanostictus, and Chub Mackerel, Scomber japonicus: Possible Processes and Management Strategy. Submitted to Jpn. Sci. Fish. Soc.
- G. M. Daskalov, D. C. Boyer and J. P. Roux. Relating sardine Sardinops sagax abundance to environmental indices in Northern Benguela. Submitted Progr. Oceanogr.
- F. Koester and 10 others. Environmental indices in fish stock assessment and management procedures: state of the art in pelagic fish stocks. In preparation.
- J. De Oliveira, A. Uriarte and M. Niquen.Benefits of using environmental predictors of fish recruitment in the management of three anchovy stocks managed through OMPs. In preparation

INDICATORS FOR INTEGRATED COASTAL MANAGEMENT:

http://www.udel.edu/CMS/csmp/indicators/

A joint effort of the Department of Fisheries and Oceans (DFO), Government of Canada, and the Intergovernmental Oceanographic Commission (IOC) of UNESCO (with the support of the U.S. National Oceanic and Atmospheric Administration) to foster scientific discussion on the development and application of indicators for Integrated Coastal Area Management was initiated through the organization of an International Workshop on the Role of Indicators for ICM, Ottawa, April 29, May 1, 2002). As a result, an international project is to be established by IOC and its partners, with the following objectives:

i) Develop appropriate methods and guidelines in evaluating ICM programs and projects using indicators following up on the recommendations of the Ottawa Workshop;
ii) Pilot test and replicate the use of the methodology on a number of ICM programs and projects and disseminate information gained and lessons learned from these pilot tests on the Global Web Service on Integrated Coastal Management;
iii) Support capacity building in evaluation techniques in ICM at the national level through the use of both distance learning educational and training tools, and face-to-face techniques.

Expected Outputs

- Publication of a Reference Guide on the Use of Indicators for Integrated Coastal Area Management (including IOC-DFO Workshop Report), IOC Manuals and Guides No. 45, ICAM Dossier No.1, February 2003

- Special Issue of *Ocean and Coastal Management* Journal on ICAM Indicators, to be published 1st half of 2003.

- *A methodological guide to the use of indicators in ICM*— refining a robust list of environmental, socioeconomic, and governance indicators. A set of generic guidelines on the use of the indicators will be developed that can be applied to any ICM project or program at the national/local level.

- *A standard, global training course for ICM managers in the use of indicators*— The development of the training courses will be preceded by a Training Needs Analysis, which will involve a survey among ICM practitioners of their needs in monitoring and evaluation in ICM and training specifically on the use of ICM indicators.

- Dedicated Web Site on ICAM Indicators

IOC MANUALS AND GUIDES

No.	Title
1 rev. 2	Guide to IGOSS Data Archives and Exchange (BATHY and TESAC). 1993. 27 pp. (English, French, Spanish, Russian)
2	International Catalogue of Ocean Data Station. 1976. (*Out of stock*)
3 rev. 3	Guide to Operational Procedures for the Collection and Exchange of JCOMM Oceanographic Data. Third Revised Edition, 1999. 38 pp. (English, French, Spanish, Russian)
4	Guide to Oceanographic and Marine Meteorological Instruments and Observing Practices. 1975. 54 pp. (English)
5 rev.	Guide for Establishing a National Oceanographic Data Centre, 1997. 42 pp. (English)
6 rev.	Wave Reporting Procedures for Tide Observers in the Tsunami Warning System. 1968. 30 pp. (English)
7	Guide to Operational Procedures for the IGOSS Pilot Project on Marine Pollution (Petroleum) Monitoring. 1976. 50 pp. (French, Spanish)
8	(*Superseded by IOC Manuals and Guides No. 16*)
9 rev.	Manual on International Oceanographic Data Exchange. (Fifth Edition). 1991. 82 pp. (French, Spanish, Russian)
9 Annex I	(*Superseded by IOC Manuals and Guides No. 17*)
9 Annex II	Guide for Responsible National Oceanographic Data Centres. 1982. 29 pp. (English, French, Spanish, Russian)
10	(*Superseded by IOC Manuals and Guides No. 16*)
11	The Determination of Petroleum Hydrocarbons in Sediments. 1982. 38 pp. (French, Spanish, Russian)
12	Chemical Methods for Use in Marine Environment Monitoring. 1983. 53 pp. (English)
13	Manual for Monitoring Oil and Dissolved/Dispersed Petroleum Hydrocarbons in Marine Waters and on Beaches. 1984. 35 pp. (English, French, Spanish, Russian)
14	Manual on Sea-Level Measurements and Interpretation.
	Vol. I: Basic Procedure. 1985. 83 pp. (English, French, Spanish, Russian)
	Vol. II: Emerging Technologies. 1994. 72 pp. (English)
	Vol. III: Reappraisals and Recommendations as of the year 2000. 2002. 55 pp. (English)
15	Operational Procedures for Sampling the Sea-Surface Microlayer. 1985. 15 pp. (English)
16	Marine Environmental Data Information Referral Catalogue. Third Edition. 1993. 157 pp. (Composite English/French/Spanish/Russian)
17	GF3: A General Formatting System for Geo-referenced Data
	Vol. 1: Introductory Guide to the GF3 Formatting System. 1993. 35 pp. (English, French, Spanish, Russian)
	Vol. 2: Technical Description of the GF3 Format and Code Tables. 1987. 111 pp. (English, French, Spanish, Russian)
	Vol. 3: Standard Subsets of GF3. 1996. 67 pp. (English)
	Vol. 4: User Guide to the GF3-Proc Software. 1989. 23 pp. (English, French, Spanish, Russian)
	Vol. 5: Reference Manual for the GF3-Proc Software. 1992. 67 pp. (English, French, Spanish, Russian)
	Vol. 6: Quick Reference Sheets for GF3 and GF3-Proc. 1989. 22 pp. (English, French, Spanish, Russian)
18	User Guide for the Exchange of Measured Wave Data. 1987. 81 pp. (English, French, Spanish, Russian)
19	Guide to IGOSS Specialized Oceanographic Centres (SOCs). 1988. 17 pp. (English, French, Spanish, Russian)
20	Guide to Drifting Data Buoys. 1988. 71 pp. (English, French, Spanish, Russian)
21	(*Superseded by IOC Manuals and Guides No. 25*)
22	GTSPP Real-time Quality Control Manual. 1990. 122 pp. (English)
23	Marine Information Centre Development: An Introductory Manual. 1991. 32 pp. (English, French, Spanish, Russian)
24	Guide to Satellite Remote Sensing of the Marine Environment. 1992. 178 pp. (English)

25 Standard and Reference Materials for Marine Science. Revised Edition. 1993. 577 pp. (English)
26 Manual of Quality Control Procedures for Validation of Oceanographic Data. 1993. 436 pp. (English)
27 Chlorinated Biphenyls in Open Ocean Waters: Sampling, Extraction, Clean-up and Instrumental Determination. 1993. 36 pp. (English)
28 Nutrient Analysis in Tropical Marine Waters. 1993. 24 pp. (English)
29 Protocols for the Joint Global Ocean Flux Study (JGOFS) Core Measurements. 1994. 178 pp . (English)
30 MIM Publication Series:
Vol. 1: Report on Diagnostic Procedures and a Definition of Minimum Requirements for Providing Information Services on a National and/or Regional Level. 1994. 6 pp. (English)
Vol. 2: Information Networking: The Development of National or Regional Scientific Information Exchange. 1994. 22 pp. (English)
Vol. 3: Standard Directory Record Structure for Organizations, Individuals and their Research Interests. 1994. 33 pp. (English)
31 HAB Publication Series:
Vol. 1: Amnesic Shellfish Poisoning. 1995. 18 pp. (English)
32 Oceanographic Survey Techniques and Living Resources Assessment Methods. 1996. 34 pp. (English)
33 Manual on Harmful Marine Microalgae. 1995. (English)
34 Environmental Design and Analysis in Marine Environmental Sampling. 1996. 86 pp. (English)
35 IUGG/IOC Time Project. Numerical Method of Tsunami Simulation with the Leap-Frog Scheme. 1997. 122 pp. (English)
36 Methodological Guide to Integrated Coastal Zone Management. 1997. 47 pp. (French, English)
37 Post-Tsunami Survey Field Guide. First Edition. 1998. 61 pp. (English, French, Spanish, Russian)
38 Guidelines for Vulnerability Mapping of Coastal Zones in the Indian Ocean. 2000. 40 pp. (French, English)
39 Cancelled
40 Guidelines for the Study of Shoreline Change in the Western Indian Ocean Region. 2000. 73 pp. (English)
41 Potentially Harmful Marine Microalgae of the Western Indian Ocean
Microalgues potentiellement nuisibles de l'océan Indien occidental. 2001. 104 pp. (English/French)
42 Des outils et des hommes pour une gestion intégrée des zones côtières - Guide méthodologique, vol.II/
Steps and Tools Towards Integrated Coastal Area Management – Methodological Guide, Vol. II. 2001. 64 pp. (French, English; Spanish)
43 Black Sea Data Management Guide (*Under preparation*)
44 Submarine Groundwater Discharge in Coastal Areas - Management implications, measurements and effects (*Under preparation*)
45 A Reference Guide on the Use of Indicators for Integrated Coastal Management. 2003. 127 pp. (English). ICAM Dossier No. 1