A handbook

for measuring the progress and outcomes of Integrated Coastal and Ocean Management

Fisheries and Oceans Canada
Pêches et Océans Canada

National Oceanic and Atmospheric Administration

Gerard J. Mangone Center for Marine Policy

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

ICAM

Intergovernmental Oceanographic Commission
Manuals and Guides, 46; ICAM Dossier, 2

A handbook

for measuring the progress and outcomes of integrated coastal and ocean management

Editor and Contributing Writer: Sherry Heileman
Designer: Eric Loddé

Prepared by Stefano Belfiore, Julian Barbière, Robert Bowen, Biliana Cicin-Sain, Charles Ehler, Camille Mageau, Dan McDougall, Robert Siron

For bibliographic purposes, this document should be cited as follows:

A Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management. IOC Manuals and Guides, 46; ICAM Dossier, 2. Paris, UNESCO, 2006 (English)

Printed in 2006
by Graph2000

(SC-2006/WS/41)

Table of contents

Acknowledgements

This handbook is the product of a collective effort. A follow-up to the *Reference Guide on the Use of Indicators for Integrated Coastal Management*, published in 2003, the preparation of this handbook involved the collaboration of several experts and practitioners in the field of natural and social sciences and management of natural resources.

The finalization of the handbook would have not been possible without the generous contribution of the Canadian Department of Fishery and Oceans (DFO), the U.S. National Oceanic and Atmospheric Administration (NOAA), the Intergovernmental Oceanographic Commission of UNESCO (IOC) and the Gerard J. Mangone Center for Marine Policy (CMP) of the University of Delaware. In this respect, particular thanks for their leadership and support go to Camille Mageau (DFO), Charles "Bud" Ehler (formerly NOAA), Julian Barbière (IOC) and Biliana Cicin-Sain (CMP).

The principal authors also include Stefano Belfiore (IOC), Dan McDougall and Robert Siron (DFO), and Robert Bowen (University of Massachusetts). A special contribution was provided by interns Fabio Ledda (University of Sassari) and Francesca Santoro (University of Venice) during their internship at IOC in Paris.

Substantial comments were provided by a panel of international experts in the field of integrated coastal and ocean management, who pointed out to necessary improvements. For this, we would like to thank Françoise Breton (European Topic Centre on Terrestrial Environment, European Environment Agency), Peter Burbridge (University of Newcastle), Jacques Denis (IFREMER), Yves Henocque (IFREMER), Stephen Olsen (Coastal Resources Center, University of Rhode Island), Horst Salzwedel (formerly GTZ), and Ivica Trumbic (Regional Activity Centre for Priority Actions Programme, Mediterranean Action Plan).

The task of editing the handbook was entrusted to Sherry Heileman, who ensured improved and harmonized content, format, and style.

Eric Loddé provided the beautiful and practical graphic design necessary for a handbook.

The approach and the indicators developed in the handbook have been tested by a number of ICAM efforts. The role of the test has been essential in the revision of the handbook and the role of all those who participated in the exercise and contributed to improve it is gratefully acknowledged:

- Canada, Eastern Scotian Shelf Integrated Management (ESSIM) Initiative (Lead agency: Department of Fisheries and Oceans): Jo Arbour and Danny Walmsley
- Chile, National Policy for the Coastal Fringe (Lead agency: Undersecretary of the Navy): Fernando Almuna
- China, Xiamen ICM Project (lead agency: Xiamen Ocean and Fisheries Bureau): Zhou Qiulin
- France, Thau Lagoon - Integrated Management Project GITHAU (lead agency: IFREMER): Jacques Denis, Thierry Laugier, Thibaut Rodriguez, Lionel Loubersac
- Denmark/Germany/Netherlands, Trilateral Wadden Sea Cooperation (lead agency: Wadden Sea Common Secretariat): Jens Enemark and Folkert de Jong
- Germany, Research for an Integrated Coastal Zone Management in the Oder/Odra Estuary Region Project (ICZM-Oder) (lead agency: Baltic Sea Research Institute): Gerald Schernewski, Jens Hoffmann, Nardine Löser, Markus Dreisewerd, Petra Stavenhagen & Bianka Grunow
- Tanzania, Marine and Coastal Environment Management Project (MACEMP) (lead agency: National Environmental Management Council): Magnus Ngoile and Jeremiah Daffa
- Thailand, Coastal Habitats and Resource Management (CHARM) Project (lead agency: CHARM EU Team): Yves Henocque and Sanchai Tandavanitj

It is our hope that this handbook may serve the needs of those coastal and ocean managers confronted with the daily tasks of measuring the progress of their programmes and projects and isolating their ecological and socioeconomic outcomes. As such, the handbook represents a tool that will further benefit from the practical application in different coastal and ocean contexts, gaining from the feedback of the users.

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.

Whilst, we are all aware of the fundamental role of Integrated Coastal Area Management as a prerequisite of sustainable development, ICAM is an evolving concept that is subject to the constant change of the communities and environments in which it functions. It is therefore essential that we establish ways of monitoring and assessing our management efforts so they are adaptive in nature, and so that we may learn from our relative successes and failures. Indicators are valuable tools that can reflect changes in both the biological and socio-economic environments, thus allowing us to observe the effects of ICAM.

This *Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management* is the culmination of four years of work, organized under the umbrella of the IOC Programme on ICAM, through a long-standing partnership with NOAA, DFO (Canada) and the Center for Marine Policy (University of Delaware, USA). Starting from the 1st Indicator Workshop organized in 2002 under the auspices of IOC and DFO, the need to harmonize and codify measuring practices has become obvious.

In addressing integrated coastal and ocean management (ICOM), the authors refer to a dynamic, multidisciplinary, iterative and participatory process to promote sustainable management of coastal and ocean areas balancing environmental, economic, social, cultural and recreational objectives over the long-term. ICOM entails the integration of all relevant policy areas, sectors, and levels of administration. It means integration of the terrestrial and marine components of the target territory, in both time and space. ICOM, therefore, is an approach to manage not only coastal areas but exclusive economic zones and large marine ecosystems, serving the purposes of national ocean policies.

We hope this contribution to the international debate will not only assist coastal managers in making their programmes more efficient, accountable and responsive to environmental and societal changes, but also will promote the exchange of experiences amongst coastal and marine professionals.

Patricio A. Bernal
Executive Secretary, IOC
Assistant Director-General, UNESCO

1 Introduction

About this handbook

- The handbook aims to contribute to the sustainable development of coastal and marine areas by promoting a more outcome-oriented, accountable and adaptive approach to ICOM.
- It provides a step-by-step guide to help users in developing, selecting and applying a common set of governance, ecological and socioeconomic indicators to measure, evaluate and report on the progress and outcomes of ICOM interventions.
- Intended as a generic tool with no prescriptive character, the handbook proposes analytical frameworks and indicators that form the basis for the customized design of sets of indicators.
- The handbook also includes results, outcomes and lessons learned from eight pilot case studies conducted in several countries. A network of ICOM experts in these countries has also been established.
- The target audience is wide, and includes coastal and ocean managers, practitioners, evaluators and researchers.
- The handbook forms part of an IOC toolkit on indicators. Its preparation is part of an effort to promote the development and use of ICOM indicators led by the Intergovernmental Oceanographic Commission, the Department of Fisheries and Oceans of Canada and the U.S. National Oceanic and Atmospheric Administration.

1. Introduction

Depleted fish stocks, degradation of coastal and marine areas, as well as user conflicts have prompted calls from the international community for an integrated approach to managing these areas. Nearly 700 initiatives in Integrated Coastal and Ocean Management (ICOM) are estimated to have been initiated in more than 140 countries since the mid-1960s (Sorensen, 2002). To date, however, it is probable that only half of these efforts have been fully implemented. Furthermore, there is a need to improve ICOM monitoring and evaluation practices for better results, accountability and adaptive management. Effective monitoring and evaluation is widely recognized as an indispensable tool in project and programme planning and management.

If done well, a monitoring and evaluation plan and associated indicators serve both as a corrective function during the project cycle, enabling timely adjustments, and as a guide to structuring future projects more effectively.

Sustainable use of coastal and ocean areas and their resources must involve the consideration of governance, ecological (including environmental) and socioeconomic dimensions, as well as the interaction between them; this must form the basis of ICOM programmes. Therefore, monitoring and evaluation of ICOM programmes rely on the use of indicators classified as governance, ecological and socioeconomic indicators, reflecting the three dimensions of ICOM.

The application of indicators in ICOM is still in its infancy. While environmental indicators have long been used to monitor the state of the coastal and marine environment, socioeconomic indicators have seen very limited application, and governance indicators have been applied mainly in reporting of the management process. A great challenge lies in developing appropriate sets of governance, ecological and socioeconomic indicators that will allow decision-makers to determine whether ICOM interventions are achieving their intended goals.

1.1 Purpose, rationale and background

This handbook was conceived in response to the need for improved approaches for monitoring, evaluating and reporting on ICOM progress and results, in particular in relation to: a) the institutionalization of monitoring and evaluation systems in ICOM ; b) the integrated consideration of governance, ecological and socioeconomic dimensions; c) the need to distinguish outcomes of ICOM initiatives from those of other initiatives, as well as from natural ecological variability; d) the linkages between ICOM reporting and state of the coast reporting; and d) consistency of approaches and comparability of progress and results of ICOM initiatives in different areas or countries.

The preparation of this handbook is part of an effort to promote the development and use of ICOM indicators led by the Intergovernmental Oceanographic Commission (IOC) of UNESCO, the Department of Fisheries and Oceans (DFO) of Canada and the and the U.S. National.

National Oceanic and Atmospheric Administration (NOAA). It began with an expert workshop held in Ottawa from 29 April to 1 May 2002 ("The Role of Indicators in Integrated Coastal Management") and as a follow-up to the IOC Reference Guide on the Use of Indicators for Integrated Coastal Management (IOC, 2003a). Directions for the elaboration of the handbook were developed at a second expert workshop held at the IOC in Paris on 8 and 9 July 2003.

1.2 Audience and use of the handbook

The handbook targets a wide audience, which includes coastal and ocean managers, practitioners and evaluators (Box 1-1). This initiative can be viewed as an open-ended partnership that is open to participation by managers, evaluators, donors and others, including through cooperation with global and regional observation and monitoring programmes and with initiatives of regional or sectoral scope (e.g., marine protected areas, coastal tourism, or integrated coastal area and river basin management). In this regard, the opportunity to ensure wider dissemination of the products in different languages will also be considered.

In addition, the handbook could also be used for capacity building in monitoring and evaluating ICOM initiatives. The inclusion of recently developed and tested approaches and methods makes the handbook a reference document

Box 1-1 Target audience

The handbook is intended to assist a range of users who deal with ICOM from different perspectives and at different geographic scales:

Managers
Officials who administer ICOM programmes or projects, and who need to improve their skills in the design, implementation, evaluation and revisions of these programmes.

Decision-makers
High-level officials who may not have specific knowledge of ICOM, but who should be familiar with the objectives and expected outcomes of ICOM initiatives and their related responsibilities.

Practitioners
Experts who are engaged in implementing ICOM tasks in the field, and who need to improve their technical skills.

Researchers
Investigators who are active in research on policy related to coastal and marine sectors, and who want to improve their knowledge of the policy cycle of ICOM, as well as of the contribution of scientific research to management.

Donors
Programme managers and evaluators from multilateral and bilateral donor agencies who want to improve the approaches and methods for monitoring and evaluating ICOM initiatives and to enhance the benefits of investments in ICOM.

for persons engaged in indicator-related research and applications. It is hoped that this would stimulate further research and more focused applications.

The handbook is based on two main components that should be considered together:

1. A proposed indicator framework that integrates governance, ecological and socioeconomic dimensions, with a focus on outcomes or results rather than on processes;
2. Proposed menus of indicators for ICOM based on previous experiences, literature review and testing exercises. Users can adapt the indicators to suit their specific needs by further developing, testing and refining them.

Also incorporated are results, outcomes and lessons learned from eight pilot case studies (test projects) conducted from September 2005 to June 2006 in several countries (Box 1-2). These studies provide examples of the development and application of ICOM indicators through their testing and validation in real situations. They serve as a reference for the adaptation of the approaches suggested in the handbook, use of which should be in conjunction with the companion collection of the case studies. More detailed information is provided in chapter 6, as well as in the reports of the individual case studies.

1.3 Contribution to improving indicators and management practices

The handbook contributes in practical terms to current efforts to develop ICOM indicators by:

- Being based on the latest concepts about sustainable development indicators, moving away from purely environmental and process-oriented indicators to integrate governance, ecological and socioeconomic dimensions into outcome-oriented frameworks;
- Relying on experience in the practical application of indicators in established ICOM initiatives and on recent testing for refinement and customization;
- Highlighting the difficulties usually experienced in establishing monitoring and evaluation systems for ICOM;
- Contributing to the improvement of the design of new ICOM programmes and projects;
- Defining measurable objectives for ICOM programmes and projects, and identifying meaningful indicators to monitor implementation and evaluate the results;
- Encouraging linkages with global and regional efforts to promote sustainable coastal and marine development; and
- Providing information on sources and repositories of data.

Box 1-2 Pilot case studies

1. Canada, Eastern Scotian Shelf Integrated Management (ESSIM) Initiative (Lead agency: Department of Fisheries and Oceans);
2. Chile, National Policy for the Coastal Fringe (Lead agency: Undersecretary of the Navy);
3. China, Xiamen ICM Project (Lead agency: Xiamen Ocean and Fisheries Bureau);
4. France, Thau Lagoon - Integrated Management Project GITHAU (Lead agency: IFREMER);
5. Denmark/Germany/Netherlands, Trilateral Wadden Sea Cooperation (Lead agency: Wadden Sea Common Secretariat);
6. Germany, Research for an Integrated Coastal Zone Management in the Oder/Odra Estuary Region Project (ICZM-Oder) (Lead agency: Baltic Sea Research Institute);
7. Tanzania, Marine and Coastal Environment Management Project (MACEMP) (Lead agency: National Environmental Management Council);
8. Thailand, Coastal Habitats and Resource Management (CHARM) Project (Lead agency: CHARM EU Team).

1.4 Other tools

The handbook forms part of an IOC toolkit on indicators, which includes:

- *The Reference Guide on the Use of Indicators for Integrated Coastal Management*, published in 2003;

- The 2003 special issue of *Ocean & Coastal Management* on "The Role of Indicators for Integrated Coastal Management";
- The collection of case studies in development and application of indicators for ICOM (prepared as the testing and refinement component of this exercise);
- A regularly updated web site (http://ioc3.unesco.org/icam/) with results from the project, publications, a clearinghouse of projects and relevant links; and
- A training module to be delivered on site (e.g., through IOC regional offices) and online.

The availability of the handbook and related materials online (http://ioc3.unesco.org/icam/) provides an opportunity for discussion and dissemination of additional information and a venue for the update of, and follow-up to, the handbook.

An important output of this exercise is the establishment of a network of ICOM experts in several countries.

1.5 Structure and organization of the handbook

The rest of the handbook is organized as follows:

- **Chapter 2**: Provides an introduction to the ICOM process and discusses ways to establish outcome-oriented targets for ICOM programmes. It also provides fundamental concepts, definitions and applications of indicators in the context of management, including uses within "state of the environment" or "state of the coast" reporting, as well as global, regional and national observation and monitoring systems;
- **Chapter 3**: Describes governance indicators, focusing on the quality of management processes, as well as on the establishment and sustainability of ICOM programmes and projects. Chapters 3, 4 and 5 also include guidelines on the selection and measurement of the indicators;
- **Chapter 4**: Describes ecological indicators for measuring the state of coastal and ocean ecosystems and the impact of ICOM initiatives;
- **Chapter 5**: Describes socioeconomic indicators for measuring socioeconomic conditions in coastal and ocean areas, including impacts of ICOM initiatives;
- **Chapter 6**: Focuses on the application of the indicators in the case studies;
- **Chapter 7**: Summarizes the main findings and lessons learned from the application of the indicators in the pilot case studies, discusses key factors influencing the effectiveness of ICOM process and provides recommendations for approaches in the development and use of ICOM indicators.

Use of indicators in Integrated Coastal and Ocean Management

2.1 Introduction

The major goal of ICOM is to contribute to sustainable development and utilization of coastal and ocean areas and their biological resources. ICOM is a dynamic, multidisciplinary, iterative and participatory process to promote sustainable management of coastal and ocean areas balancing environmental, economic, social, cultural and recreational objectives over the long-term. ICOM employs a comprehensive method of planning and managing human activities within a defined coastal or ocean area, taking into account the relevant ecological, social, cultural and economic dimensions and the interactions between them. Ideally, an ICOM programme should operate within a closely integrated and coherent management framework within a defined geographical limit (Chua, 1993).

This chapter provides an introduction to ICOM and discusses the use of various frameworks and indicators in analysing the effectiveness of ICOM programmes.

2.2 Functions of ICOM

The functions of ICOM are wide-ranging, and include the promotion of environmentally compatible economic development, the protection of coastal and marine habitats and biodiversity, as well as area-based planning (Table 2-1).

ICOM also addresses specific issues such as beach stabilization, conservation of coastal and marine habitats and biodiversity, protection of the coastal and marine environment from land-based pollution, unsustainable fisheries and tourism, as well as impacts from climate change and sea level rise. Often, an ICOM intervention is initiated in response to a specific issue. This lays the foundation for the development of a more complex ICOM programme in the future.

2.3 Principles and international guidelines on ICOM

ICOM is based on several principles, with sustainable development being the overarching principle.

Table 2-1 Examples of ICOM goals and functions

Goals	Functions
Area planning	• Plan for present and future uses of ocean and coastal areas • Provide a long-term vision
Promotion of economic development	• Promote appropriate uses of ocean and coastal areas (e.g., marine aquaculture, ecotourism)
Stewardship of resources	• Protect the ecological base of ocean and coastal areas • Preserve biological diversity • Ensure sustainability of uses
Conflict resolution	• Harmonize and balance existing/potential uses • Address conflicts among ocean and coastal uses
Protection of public safety	• Protect public safety in ocean and coastal areas typically prone to significant natural, as well as human-induced, hazards
Proprietorship of public submerged lands and waters	• As governments are often outright owners of specific ocean and coastal areas, manage government-held areas and resources wisely and with good economic returns to the public

Sustainable development of coasts and oceans

Sustainable development of coasts and oceans seeks to maximize the economic, social and cultural benefits that can be derived from these ecosystems without compromising their health and productivity. An ecosystem-based approach to management (EBM) is widely recognized as an effective path to sustainable development. EBM focuses on maintaining the functional and structural integrity of the ecosystem, on which its health and productivity depend. This approach recognizes the role of humans within the ecosystem in terms of their use of natural resources and the direct and indirect impacts of their activities. Ensuring ecosystem health requires, among others, the management of human behaviour and activities so as to minimize their negative impacts on ecosystems.

To understand ecosystems and monitor changes, EBM considers all forms of relevant information, including scientific, indigenous and local knowledge, innovations and practices in planning and decision-making, and considers that all relevant sectors of society and scientific disciplines should be involved (CBD/COP, 1998).

Sustainable development of coasts and oceans is also based on the premise that management of these areas must be a collaborative effort among all stakeholders, as well as on the principles of integrated management of all activities occurring in or effecting coasts and oceans. Coastal and ocean areas usually involve multiple users, various government agencies at different levels (e.g., national, provincial, local) and, in the case of shared seas, interactions with other nations. In addition, these areas are affected by both land and freshwater issues, which implies the application of knowledge from various disciplines in their management. Thus a central element of ICOM is integration within the following dimensions: intersectoral, intergovernmental, spatial, scientific and international (Cicin-Sain and Knecht, 1998).

As integrated management takes into consideration governance, ecological, social and economic factors for a given management area, it is important that these factors are reflected in the management objectives. Therefore, objectives can be grouped into three general categories – governance, ecological and socioeconomic objectives.

Environment and development principles

ICOM is also guided by the principles on environment and development that have been endorsed by the international community at the 1992 United Nations Conference on Environment and Development (UNCED) and in subsequent international agreements, e.g., the right to develop; inter-generational equity; environmental assessments; precautionary approach; polluter-pays principle; and openness and transparency in decision-making.

The special character of coasts and oceans

Principles related to the special character and the public nature of coasts and oceans, as well as of the use of their resources also provide guidance for ICOM (Cicin-Sain and Knecht, 1998). Special characters include high productivity, great mobility and interdependence of coastal and ocean systems, as well as their linkages with terrestrial areas, which requires managing these systems as a single, integrated unit.

Principles related to the public nature of coasts and oceans and of the use of their resources are based on the open access nature (public domain) of coastal and ocean resources. Management must therefore be guided by stewardship ethics, fairness and equity among all users, as well as by according priority to protecting living resources and their habitats over the exploitation of non-living, non-renewable resources, in the case of irreconcilable conflicts.

Table 2-2 Main international frameworks of relevance to ICOM

Year	Organization	Framework
1992	United Nations (UN)	Agenda 21, Chapter 17
1993	Organization for Economic Corporation and Development (OECD)	Coastal Zone Management: Integrated Policies
	World Bank	Guidelines for Integrated Coastal Zone Management
	World Conservation Union (IUCN)	Cross-Sectoral, Integrated Coastal Area Planning: Guidelines and Principles for Coastal Area Development
1995	United Nations Environment Programme (UNEP)	Guidelines for Integrated Management of Coastal and Marine Areas: With Special Reference to the Mediterranean Basin
1996	UNEP	Guidelines for Integrated Planning and Management of Coastal and Marine Areas in the Wider Caribbean Region
1998	Food and Agriculture Organization (FAO)	Integrated Coastal Management and Agriculture, Forestry and Fisheries
1999	UNEP	Conceptual Framework and Planning Guidelines for Integrated Coastal Area and River Basin Management
	European Community (EC)	Towards a European Integrated Coastal Zone Management (ICZM) Strategy: General Principles and Policy Options
	Council of Europe	European Code of Conduct for Coastal Zones
2000	Convention on Biological Diversity (CBD)	Review of Existing Instruments Relevant to Integrated Marine and Coastal Area Management and their Implementation for the Implementation of the CBD
2004	CBD	Integrated Marine and Coastal Area Management (IMCAM) Approaches for Implementing the CBD

Relevant international guidelines

All of the major agreements emanating from UNCED and other international fora have endorsed the application of an integrated approach to management of coasts and oceans. The main international frameworks and guidelines of relevance to ICOM are given in Table 2-2. While these frameworks emphasize different functions of ICOM (such as in preserving biodiversity, addressing climate change), there is consensus among them regarding the scope and purposes of ICOM, as well its major approaches and principles. These frameworks are also important since they set international standards for ICOM. A number of efforts have also been made by international agencies to further define, interpret and implement the ICOM concept.

Guidelines developed in the context of international meetings are also relevant to the application of ICOM, e.g., the statements of the World Coast Conference (Beukenkamp et al., 1993), the Guidelines for Enhancing the Success of ICM (IWICM, 1996) and the Guidelines for Integrating Coastal Management Programmes and National Climate Change Action Plans (Cicin-Sain et al., 1997).

2.4 The ICOM process

The general elements of the ICOM process are illustrated in Figure 2-1 (Henocque and Denis, 2001). This process involves three phases, each with individual steps, the sequence of which may vary, depending on the characteristics of the management

area. In some cases, all steps may not be required or needed to be completed in the linear progression as outlined:

Phase I: Preliminary identification. Focuses on the initial conditions that prompt the initiation of an ICOM intervention (e.g., an environmental crisis), as well as the spatial context.

Step 0: Initialization conditions. Identification of the players involved in the ICOM process (e.g., the existence of a pioneer group) and the overall political, institutional, economic and social context.

Step 1: Feasibility. The feasibility of implementation of the ICOM process is determined, and the available resources (human, technical, financial and scientific information) as well as a task force representative of all the stakeholders and interests groups (institutional, disciplinary and geographic) identified. In this step the task force supervises the preparation of a fact-finding report (on existing environmental and socioeconomic conditions), main issues, players concerned and possible solutions in the form of economic, environmental and land-use plans). This report should be regularly submitted to all the players for validation in the course of the process.

Phase II: Preparation of the management process and plans. The goal of this phase is not necessarily to produce a detailed diagnostic. There are four steps in this phase:

Step 2: Social and environmental assessments.

Step 3: Development of desirable and possible scenarios, identification of institutional and social and environmental conditions, resources and data available.

Step 4: Preparation of a management plan based on ICOM principles, goals and objectives. Communication is a key element of this phase, through the production of reports of inventories and social and environmental assessments that should be presented to the players for use in evaluation. An important aim of this phase is to make explicit basic facts about the players (e.g., in relation to the environmental problems, their participation in decision-making and their contribution to the ICOM process, as well as their activities and operations).

Phase III: Consolidation, replication and expansion

Step 5: Institutionalization of the necessary mechanisms for the implementation of the ICOM process (e.g., coordinating bodies, conflict resolution mechanisms), following formal adoption of the management plan.

Step 6: Implementation of the management plan through the organization of activities and participation of the players.

Step 7: Evaluation and adjustment of the ICOM process, activities, outputs and outcomes, based on the performance of each phase. Evaluation should be a repeated throughout the project cycle.

When an ICOM process has been initiated at the local level through one or more demonstration projects, a fourth phase may be involved, concerning the development of the ICOM process at a larger spatial scale, as described in the following steps:

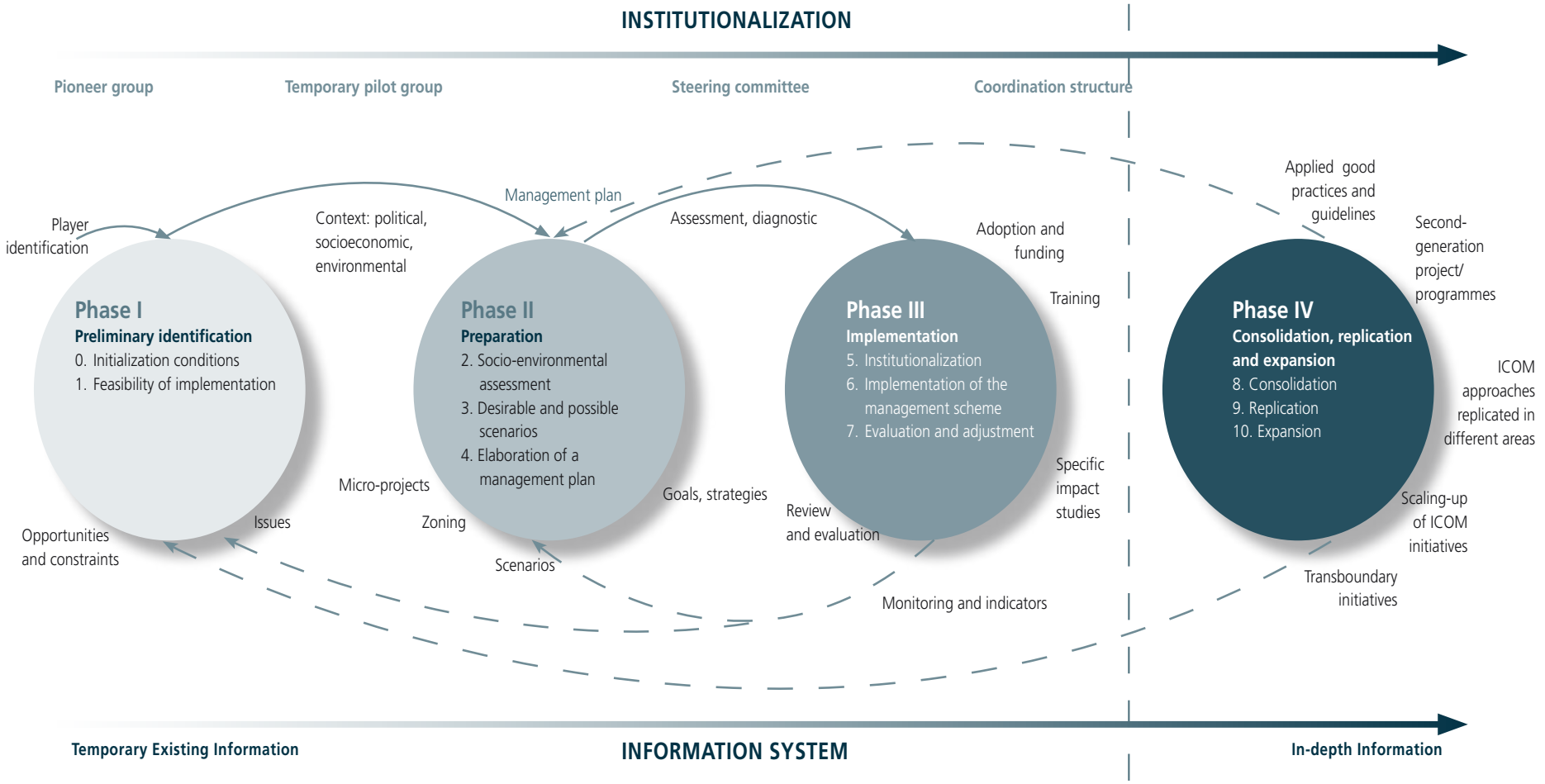
Step 8: Consolidation deals with the full utilization of results from the implementation of the ICOM process to make it more sustainable through the distillation of good practices, the formalization of institutions and the allocation of funds on the longer-term.

Step 9: Replication concerns the exchange of experience among coastal managers, the initiation of the ICOM process in other parts of the coastal and marine area, and its adaptation to other sectors influencing this area (e.g., the management of watersheds).

Step 10: Finally, the ICOM approach applied at the local or sub-national level may undergo expansion into a national plan or programme, its incorporation into a national sustainable development strategy, and even its utilization to address problems of international scope.

There has been a significant increase in the number of countries adopting ICOM, especially since UNCED. Major differences in ICOM efforts are, however, found

Figure 2-1 Elements of the ICOM Process (adapted from Henocque and Denis, 2001)



in the geographic scope, the role of national and sub-national authorities, and the extent and importance of international funding.

2.5 The role of indicators in the management process

What are "indicators"?

Indicators are quantitative/qualitative statements or measured/observed parameters that can be used to describe existing situations and measure changes or trends over time. Their three main functions are simplification, quantification and communication.

Indicators generally simplify in order to quantify complex phenomena so that communication of information to policy-makers and other interested parties, including the general public, is enabled or enhanced. They are powerful tools in the feedback loop to an action plan, as an early warning signal about an emerging issue, or in providing a concise message for engagement, education and awareness.

Characteristics of good indicators

From a scientific perspective, effective indicators should have the following characteristics:

1. **Readily measurable**, on the time-scales needed to support management, using existing instruments, monitoring programmes and available analytical tools. They should have a well-established confidence limit, and their signal should be distinguishable from background noise;
2. **Cost effective**: Indicators should be cost-effective since monitoring resources are usually limited;
3. **Concrete**: Indicators that are directly observable and measurable (rather than those reflecting abstract properties) are desirable because they are more readily interpretable and accepted by diverse stakeholder groups;
4. **Interpretable**: Indicators should reflect properties of concern to stakeholders; their meaning should be understood by as wide a range of stakeholders as possible;
5. **Grounded on scientific theory**: Indicators should be based on well-accepted scientific theory, rather than on inadequately defined or poorly validated theoretical links;
6. **Sensitive**: Indicators should be sensitive to changes in the properties being monitored (e.g., able to detect trends in the properties or impacts);
7. **Responsive**: Indicators should be able to measure the effects of management actions so as to provide rapid and reliable feedback on the consequences of management actions;
8. **Specific**: Indicators should respond to the properties they are intended to measure rather than to other factors, i.e., it should be possible to distinguish the effects of other factors from the observed responses.

From a management perspective, indicators should be:

1. Relevant to management objectives;
2. Clearly linked to the outcome being monitored;
3. Developed with all those involved in management; and
4. Part of the management process and not an end in themselves.

The role of indicators in monitoring and evaluation

Evaluations are systematic and independent assessments of ongoing or completed projects or programmes, their design, implementation and results, which aim to determine whether the actions taken have produced the desired results. Ideally, evaluation should be a continuous process through which measures of performance are defined and systematically compared with programme goals and objectives. It may also be undertaken periodically during the lifetime of a programme. In practice, evaluations are used by managers to improve their own performance (adaptive management), as well as for reporting (accountability) or as lessons learned to improve future planning.

Monitoring is the continuous or periodic process of collecting and analysing data to measure the performance of a programme, project, or activity. As an integral and continuing part of project/programme management, it provides managers and stakeholders with regular feedback on implementation and progress towards the attainment of environmental objectives. Monitoring enables management to take appropriate corrective action to achieve desired results. Effective monitoring requires baseline data, as well as indicators of performance and related measurements, regular reporting, and a feedback mechanism for management decision-making.

Information on which evaluations are based could come from many sources, but monitoring (observation) has a particularly important contribution in providing the basic data that should underpin the evaluation. In this regard, indi-

Box 2-1 Components of the project cycle

Inputs — What do we need?
Adequacy of resources in relation to management objectives, based primarily on measures of staff, funds, equipment and facilities;

Process — How do we go about it?
Adequacy of management processes and systems in relation to management objectives, related to issues such as day-to-day maintenance or adequacy of approaches to public participation;

Outputs — What did we do and what products and services were produced?
Measures of the volume of work output (e.g., number of meetings held, permits issued, surveys completed and of construction projects completed); actual versus planned work programmes; actual versus planned expenditures;

Outcomes — What did we achieve?
For example, increase in abundance of key species and communities; habitat change; improvements in environmental quality; reduced use conflicts; improvements in community well-being (increase in income, decrease in unemployment, etc.

cators provide a useful tool to identify, prioritize and quantify objectives, monitor their achievement, evaluate the programme and ultimately adjust it.

The role of indicators in ICOM

Sets of different indicators can be analysed in relation to the elements of input, process, output and outcomes in the project cycle (Box 2-1). An example of this approach is provided in Chapter 6.

Indicators should relate to the specific management issues that triggered the initiation of an ICOM process, such as multiple user conflicts, ecological degradation, community interest, or a commitment to improve the management of a local marine area. A structured approach to ICOM calls for indicators that clearly relate to the management objectives set during the planning phase.

The uses of indicators in ICOM include:

- Monitoring key compositional, structural and functional characteristics of marine ecosystems against desired conditions;
- Tracking progress and effectiveness of measures and actions (e.g., marine environmental quality objectives or the creation of marine protected areas);
- Providing a focal point to summarize consistent information for sub-national, national and international reporting, as well as across reporting scales and jurisdictions;
- Monitoring the long-term cumulative impacts of human actions on the coastal and marine environment, on ecosystem status and health, as well as of trends in the major drivers and pressures;
- Guiding adaptive management; and
- Tracking progress in the implementation of an ICOM plan, including its efficiency, effectiveness and adaptability.

ICOM indicators

ICOM indicators are of three types, reflecting the three elements of ICOM:

- Governance indicators, which measure the performance of programme components (e.g., status of ICOM planning and implementation), as well as the progress and quality of interventions and of the ICOM governance process itself;
- Ecological indicators, which reflect trends in the state of the environment. They are descriptive in nature if they describe the state of the environment in relation to a particular issue (e.g., eutrophication, loss of biodiversity or over-fishing). They become performance indicators if they compare actual conditions with targeted ecological conditions;
- Socioeconomic indicators, which reflect the state of the human component of coastal and marine ecosystems (e.g., economic activity) and are an essential element in the development of ICOM plans. They help measure the extent to which ICOM is successful in managing human pressures in a way that results not only in an improved natural environment, but also in improved quality of life in coastal areas, as well as in sustainable socioeconomic benefits.

These three categories include 15 Governance indicators, 9 ecological indicators and 13 socioeconomic indicators. Detailed indicator schedules are given in Annexes I, III, and IV.

Each indicator schedule has the following format (See also Table 2-3):

- Nature of indicator: describes the indicator definition and its unit of measurement;
- Relevance: describes the purpose of the indicator and the framework in which it has been created;
- Methodological description: describes the concept, approaches, limitation, status and other definitions of the indicator;
- Assessment of data: describes the methods to collect and analyse the data in applying the indicator;
- Additional information: lists relevant programmes, references and useful links.

There are numerous potential indicators, and judicious choices must be made based on their relevance, technical adequacy and feasibility. The specific reporting requirements will vary from one geographic area to another, hence affecting the selection of indicators, the required partnering arrangements and the cost of reporting.

Table 2-3 Format of the indicator schedules

Indicator code	Name of the indicator
Nature of indicator	Definition Unit of measurement
Relevance	Purpose International conventions, agreements and targets
Methodological description	Underlying definitions and concepts Measurement approaches Limitations of the indicator Status of the methodology Alternative definitions/indicators
Assessment of data	Data needed to compile the indicator Data sources and collection methods Analysis and interpretation of results Reporting scale and output
Additional information	Organizations and programmes involved in the development of the indicator References Internet links

The full set of indicators proposed for a given area should also be examined for complementarities among them and adequate coverage of key issues. For example, where different indicators deal with a similar coastal issue, a single indicator or a subset of indicators could be selected for development. It may also be better to group several variables into one indicator or merge some of the proposed indicators to create indices.

Concerning measures of governance performance, it is possible to identify a series of "markers" of performance associated with each step of the ICOM policy cycle. This can help to evaluate progress of the ICOM process. Examples of these markers are provided in Chapter 6 (Applying the indicators).

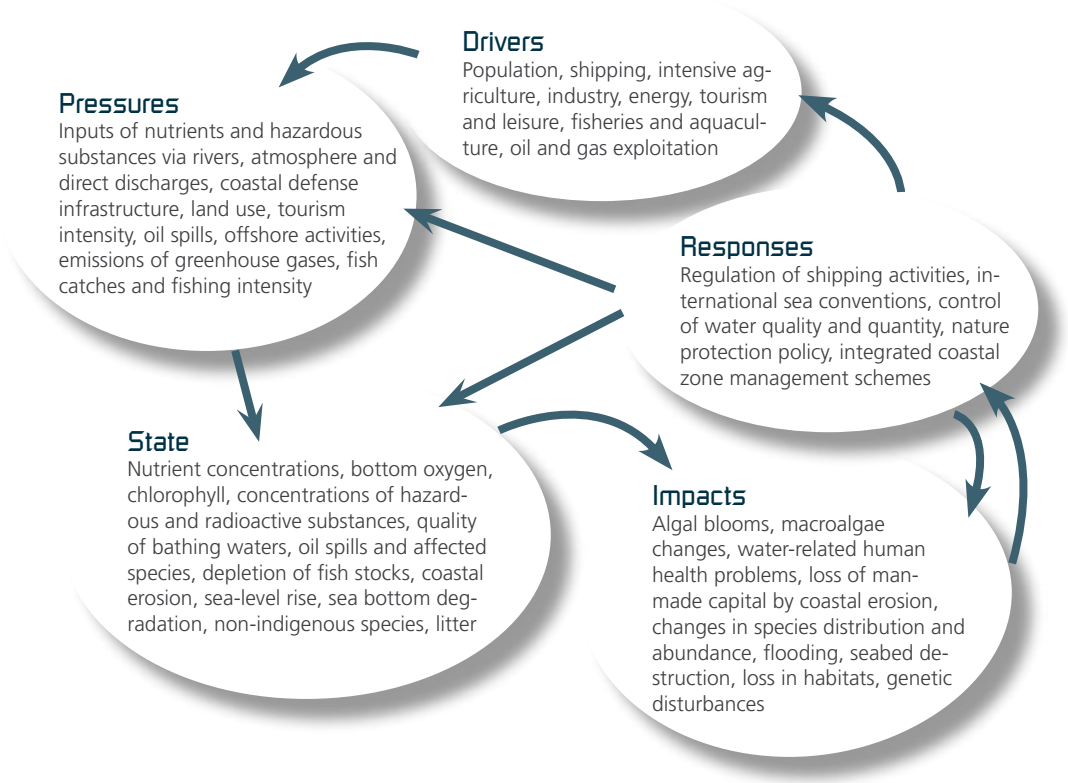
Frameworks for evaluating ICOM programmes

Among the frameworks often used for monitoring of ICOM programmes is the Driver-Pressure-State-Impact-Response (DPSIR), as illustrated in Figure 2-2 (to be inserted) (EEA, 1998), DSR (United Nations and World Bank, 2001) or PSR (OECD, 1993) frameworks and associated indicators. These frameworks are used for environmental assessments and "state of the environment" reporting.

The DPSIR framework is a convenient approach to analyse linkages among socioeconomic trends, ecological phenomena and institutional responses. It follows a causal path that goes from driving forces of environmental change (e.g., population growth and density), which lead to pressures on the environment (e.g., increased sewage outflow to coastal waters), which result in changes in the state of the environment (e.g., amounts of organic pollution in coastal waters), which in turn results in environmental and socioeconomic impacts (e.g., changes in recreational value of bathing waters) and elicits institutional responses (e.g., improvement in wastewater treatment).

In relation to state of the environment reporting, UNEP (Rump, 1996) suggests that the DPSIR framework be used to address the following fundamental questions:

Figure 2-2 **The DPSIR framework applied to the marine environment (EEA, 2000)**



- What is happening? (changes in the state of the environment and related impacts);
- Why is it happening? (causes of changes, be they natural or human, direct or indirect);
- Are the changes significant? (significance of the impacts caused by environmental changes);
- What is or could be the response? (institutional responses to environmental changes).

The EEA (2000) suggests focusing the last two questions on the effectiveness of the responses in changing driving forces and pressures.

Evaluation of the effectiveness of policy responses is a difficult undertaking in relation to ICOM, due to its multidisciplinary and multi-sectoral nature and the difference in time scales at which the effects of a certain policy may be manifested.

In the original DSR framework developed by the UN CSD (1996), indicators for driving forces, state and responses were identified for the four dimensions of sustainable development (social, economic, environmental and institutional). Examples of these indicators are given in Table 2-4 (adapted from CBD, 2004).

In the revised approach to indicators, the sustainable development indicators framework was reorganized using a thematic approach, as shown in Table 2-5 (UN, 2001).

Table 2-4 **Examples of DSR indicators for the four dimensions of sustainable development**

Dimensions of SD / Indicators	Driving forces	State	Responses
Social	Population growth rate in urban coastal areas	Income and poverty levels	Budget given to environmental education; number of awareness raising campaigns
Economic	The dependence of coastal communities on fishing	Employment in the fishing industry	The use of more efficient fishing techniques
Environmental	Changes in stream patterns	Chemical composition of water	Changes in fish population dynamics
Institutional	The level of enforcement of laws and regulations related to coastal area management	Fish consumption indices	The number of co-management arrangements to improve management efficiency

(Source: adapted from CBD, 2004)

Table 2-5 Examples of sustainable development indicators for oceans, seas and coasts

Theme	Sub theme	Example of indicators
Oceans, seas and coasts	Coastal zone	Algae concentration in coastal waters
		Percent of total population living in coastal areas
	Fisheries	Annual catch by major species

To better analyse the progress and effectiveness of ICOM interventions, the DPSIR, DSR or PSR framework should be complemented by other, more specific frameworks to evaluate the achievement of intermediate goals. Appropriate frameworks for the application of indicators in the ICOM process are shown in Table 2-6.

The DPSIR framework was applied by the German ICOM test project Oder/IKZM to select a set of indicators for the entire DPSIR cycle, reflecting the dependencies of their coastal system. The framework was seen in relation to the implementation of the European Union's Water Framework Directive (WFD). Systematic screening in the test project assessed whether an indicator was suitable for the WFD, evaluated data availability and estimated the resources needed to apply the indicator. The results supported the decision-making process about relevant indicators. This approach was successful and not very time-consuming.

Establishing baseline conditions

Performance of ICOM programmes against specified objectives and deadlines are most effectively assessed when baseline information on the governance, ecological and socioeconomic conditions of the management area is available. To this end, ecological and socioeconomic profiles of coastal zones must be developed, and an assessment of the main actors, laws and institutions relevant to ICOM carried out. Baseline information may include:

- A quantitative and qualitative inventory of coastal resources: e.g., land area, built-up area, agricultural land, land set aside for conservation and special purposes, forests, water resources, surface waters, groundwater, coastal waters, marine resources and wildlife resources;

Table 2-6 Types of conceptual frameworks and their objectives for monitoring and evaluation

Different frameworks are available for the application of indicators in ICOM initiatives and programmes, according to the purposes of ICOM. Practical examples of the application of ICOM indicators within different frameworks are provided in Chapters 4 and 6.

Framework	Objectives	Examples
DPSIR	To help with state of the environment reporting, in analysing linkages among socioeconomic trends, ecological phenomena and institutional responses using the DPSIR framework.	Example A7 and A-8, Chapter 6
Policy cycle	To assess the status and results of a programme or project through the implementation of the different steps of the programme or project cycle and the relevant progress markers and performance measures of the ICOM process.	Worksheets A-3/I-IV and Example A-6, Chapter 6
Logical framework	To improve programme implementation through the progression from inputs and processes to outputs, outcome and impacts and internal monitoring and evaluations.	Example A-5, Chapter 6
Orders of outcomes	To measure programme and project progress and effectiveness through the achievement of intermediate and final outcomes.	Example A-9, Chapter 6
Ecosystem-based approach	To identify the most important ecosystem properties and components, and the subsequent development of related ecosystem-based management objectives, using a top-down or bottom-up approach.	Figure 4-1, Chapter 4

- An inventory of main economic coastal and marine uses: e.g., industry, agriculture, tourism, fisheries and aquaculture, forestry, transport and energy;
- An inventory of infrastructure: e.g., roads, railways, water supply and sewage treatment; and
- An inventory of pollution discharges: e.g., air and water pollution, solid waste.

Such baseline information may be used to establish benchmarks and performance targets for ICOM programmes. The measurement of coastal and marine conditions and trends can then be correlated with information concerning governance and management actions to understand the effectiveness of ICOM programmes and identify gaps and issues to be addressed, review programme assumptions and adapt to changing conditions.

Spatial and temporal scales of measurement

With few exceptions, indicators are generally significant at all scales. Ideally, the measurement of indicators should be consistent with the scale of the phenomenon of interest for the governance, environmental and socioeconomic dimensions, and, where possible, with the natural boundaries of the ecosystem.

The choice of the temporal scale at which to measure each indicator may depend on individual monitoring and evaluation systems. In this regard, it may be important to organize the monitoring of the indicators according to the phases of the ICOM policy cycle. In general, an attempt should be made to measure more frequently those indicators that change more rapidly and less frequently those that change less rapidly.

Caution about the use of indicators

Although indicators are of great utility in ICOM, problems and shortfalls in their use also exist. These problems are related to the "misuse" of indicators, a poorly managed development process and using indicators for the wrong reasons. These problems are minimized when indicators form part of an established "toolbox" within an efficient process and with the availability of adequate information. Effective use of indicators should take into consideration the following concerns (IOC, 2003a):

- 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);
- Programme or project managers can be held responsible for processes or outcomes over which they have no control;
- Unrealistic expectations;
- Assessing results without consideration of the spatial/temporal context;
- An inadequate ordering framework, which can lead to confusion over how to express the indicators for a particular issue;
- Falling into the trap of trying to measure what is measurable rather than measuring what is important; and
- Dependence on a false model or false relationships amongst the indicators.

Future directions

- Improved understanding of coastal systems will allow the selection of better, more cost-effective indicators;
- Improved instrumentation will allow more sensitive detection and observations;
- Real-time measures and more powerful modelling will allow quicker capture and analysis of data;
- Visualization techniques will allow more ready use by managers;
- Indicator use will lead to better reporting and communication;
- Accountability and adaptive management will be a reality.

Further guidance on suites of governance, ecological and socioeconomic indicators for ICOM are given in the following three chapters.

3 Governance

performance indicators

Summary of governance goals, objectives and indicators

Goals	Objectives	Code	Indicators	Page
Ensuring adequate institutional, policy and legal arrangements	Ensuring the coordination and coherence of administrative actors and policies	G1	Existence and functioning of a representative coordinating mechanism for ICOM	114
	Supporting integrated management through adequate legislation and regulations	G2	Existence and adequacy of legislation enabling ICOM	117
	Assessing the environmental impacts of policies, plans, programmes and projects	G3	EIA, SEA and CCA procedures for plans, programmes and projects affecting coastal zones	120
	Resolving conflicts over coastal space and resources	G4	Existence and functioning of a conflict resolution mechanism	123
Ensuring adequate management processes and implementation	Managing the coastline through integrated plans	G5	Existence, status and coverage of ICOM plans	126
	Implementing and enforcing ICOM plans and actions	G6	Active management in areas covered by ICOM plans	129
	Routinely monitoring, evaluating and adjusting ICOM efforts	G7	Routine monitoring, evaluation and adjustment of ICOM initiatives	132
	Supporting ICOM through sustained administrative structures	G8	Sustained availability and allocation of human, technical and financial resources for ICOM, including the leverage of additional resources	135
Enhancing information, knowledge, awareness and participation	Ensuring that management decisions are better informed by science	G9	Existence, dissemination and application of ICOM-related scientific research and information	138
	Ensuring sustained support from engaged stakeholders	G10	Level of stakeholder participation in, and satisfaction with, ICOM decision-making processes	141
	Ensuring Non-governmental Organization (NGO) and Community-based Organization (CBO) involvement	G11	Existence and activity level of NGOs and CBOs supportive of ICOM	144
	Ensuring adequate levels or higher education and professional preparation for ICOM	G12	Incorporation of ICOM into educational and training curricula and formation of ICOM cadres	147
Mainstreaming ICOM into sustainable development; Economic instruments mainstreaming	Enabling and supporting ICOM through technology, including environmentally- friendly technology	G13	Use of technology, including environmentally friendly technology, to enable and support ICOM	150
	Incorporating economic instruments into coastal management policies	G14	Use of economic instruments in support to ICOM	153
	Mainstreaming coastal and ocean management into sustainable development	G15	Incorporation of ICOM into sustainable development strategy	157

3.1 Introduction

ICOM, by definition, is a governance tool used to plan and manage human activities within a defined coastal and ocean management area. Despite numerous efforts to implement and monitor the progress of ICOM at the global, regional and programme levels, difficulties are still experienced with respect to linking policy responses with observed on-the-ground changes and vice versa. Addressing this issue is becoming increasingly important because decision-makers and the public, as well as international donors and others, are demanding to see tangible results of ICOM investments.

Hence, the development of a parsimonious set of governance indicators that can be easily applied in different socio-political contexts looms as a major challenge for analysts and decision-makers alike.

3.2 Coastal and ocean governance

Coastal and ocean governance may be defined as the processes and institutions by which coastal and ocean areas are managed by public authorities in association with communities, industries, NGOs and other stakeholders through national, sub-national and international laws, policies and programmes, as well as through customs, tradition and culture, in order to improve the socio-economic conditions of the communities that depend on these areas and their living resources.

According to Cicin-Sain and Knecht (1998), the main purposes of coastal and ocean governance are to:

- Achieve sustainable development of the multiple uses of coastal and ocean areas;
- Maintain essential ecological processes, life support systems and biological diversity in coastal and ocean areas;
- Reduce vulnerability of coastal and ocean areas and their inhabitants to natural and human-induced hazards;
- Analyse and address implications of development, conflicting uses and interrelationships among physical processes and human activities in ocean and coastal areas; and
- Promote linkages and harmonization among coastal and ocean sectors and activities.

Since in most countries coastal and ocean areas are in the public domain, their governance demands: a high level of stewardship; the assumption of responsibility for their long-term wellbeing as well as that of their living resources; the promotion of sustainable development of their multiple uses; and public accountability and transparency.

Governance factors thought to be important in enabling successful ICOM interventions include (Belfiore, 2005):

- An appropriate legal authority (e.g., the establishment of a coastal/ocean law or decree);
- Appropriate institutional arrangements, such as a lead agency and an ICOM coordinating body;
- Clear geographical boundaries of the plan or programme;
- Regulatory powers and instruments for controlling development within the application area;
- Human, technical and financial resources to implement the plan or programme;
- Procedures in place for monitoring, evaluating and adjusting the plan or programme.

A key aspect of ICOM is the design of institutional processes of integration/harmonization to overcome the fragmentation inherent in the sectoral management approach and in the split in jurisdiction between levels of government at the land-water interface. A useful vehicle for achieving integration is an ICOM coordination mechanism that brings together coastal and ocean sectors, different levels of government, users and the public into the ICOM process.

3.3 ICOM governance indicators

ICOM governance performance indicators are designed to measure the performance of the responses to mitigate human pressures on the coastal and marine environment. They also measure the progress and quality of the governance process itself, that is, the extent to which a programme is addressing the issue(s) that triggered the development of the programme in the first place. Governance indicators focus on variables related to inputs, processes, outputs, outcomes and impacts of ICOM programmes.

Box 3-1 Some questions of interest to decision-makers and the public

What difference do investments in ICOM make in terms of:

- protecting coastal and ocean resources, biodiversity and the environment, and exercising stewardship on behalf of current and future generations?
- enhancing economic opportunities, public health and quality of life in coastal communities?
- resolving conflicts among current and potential uses of the coast and ocean, and in attaining balanced and orderly development of these areas?

Are management decisions about coastal and ocean areas made in an open and transparent manner involving multiple stakeholders, and are accountable to the public?
Are the management processes effective and efficient, particularly in terms of institutional and capacity development?

The use of governance performance indicators is also particularly useful in setting quantifiable objectives and related performance targets and evaluating progress towards achieving them. This is particularly important in generating continuing political and public support for ICOM programmes, as well as for providing answers to questions such as those shown in Box 3-1.

Since governance indicators measure the performance of programme components that address environmental and socioeconomic issues, a discussion of governance indicators must ultimately be related to specific improvements in environmental and socioeconomic conditions.

However, attributing changes in the environmental and socioeconomic conditions of coastal and marine areas to policy interventions is complicated by the multi-sectoral nature of ICOM and the contribution of multiple policies to single issues (e.g., water quality).

This could be addressed by taking performance measurements at regular intervals for specific issues or dimensions. The analysis of the contribution (Mayne, 1999) of ICOM programmes to environmental and socioeconomic outcomes may also help in this sense (Box 3-2).

The governance performance indicators and related measures presented in this handbook can be developed to evaluate progress towards achieving the high-level goals and objectives in four main areas:

1. Institutional coordination and coherence to ensure that (i) the functions of administrative actors are properly defined, including through the establishment of a coordinating mechanism; (ii) a legal framework exists to support ICOM and the pursuance of coherent objectives; (iii) the impacts of sectoral plans, programmes and projects potentially affecting coastal zones are taken into account through procedures for environmental impact assessment (EIA), strategic environmental assessment (SEA) and carrying capacity assessment (CCA); and (iv) conflict resolution mechanisms are available to anticipate, resolve, or mitigate conflicts over the use of coastal and marine areas and resources;
2. Quality and effectiveness of management by (i) the formal adoption of integrated management plans; (ii) active implementation of these plans; (iii) routine monitoring and evaluation of management and its outputs, outcomes and impacts, as well as the consideration of results in adaptive management;

Box 3-2 Contribution analysis

Contribution analysis relies primarily on:

- Exploring the ICOM programme logic;
- Identifying and documenting behavioural changes as a direct result of the programme;
- Using "discriminating" indicators, i.e., indicators that focus on the specific outcomes of the programme;
- Tracking performance over time;
- Exploring alternative explanations for the achieved or non-achieved outcomes; and
- Collecting additional evidence.

and (iv) the sustained availability of human, financial and technical resources to enable effective management;

3. Improved knowledge, awareness and support by ensuring (i) the production of results from scientific research, its use for management and its dissemination to a wider audience; (ii) the participation of stakeholders in decision-making processes; (iii) the activities of NGOs and CBOs; and (iv) the introduction of ICOM-related subjects into educational and training curricula for the formation of ICOM cadres;
4. Mainstreaming ICOM into sustainable development by (i) the development and application of technologies that can enable and support ICOM; (ii) the use of economic instruments to promote ICOM objectives through the private sector; and (iii) the incorporation of ICOM objectives into broader sustainable development strategies.

3.4 Selection of governance indicators

Table 3-1 provides a menu of 34 indicators, 15 (G1 – G 15) of which are key indicators and are fully developed. The others are considered potential indicators for which additional effort is required before they can be considered as key indicators (see IOC, 2003a). In general, potential indicators may not be significant in any context, may overlap with other indicators, or require significant technical and financial resources for their measurement.

In some cases, certain indicators are related to more than one objective (Figure 3-1, next page), thus providing additional means of verification of progress.

The identification and selection of governance performance indicators should be undertaken in collaboration with key stakeholders, thus facilitating the definition of a shared vision for the coastal area, the main goals and objectives and the steps to achieve it. In addition, indicators related to governance should also include a consideration of the articulation of roles and responsibilities in ICOM, in particular those of sub-national entities.

The selection of governance performance indicators should be based on a number of criteria:

a) Relevance to the policy and management needs;
b) Analytical soundness;
c) Easy to understand and communicate;
d) Responsiveness to institutional development and changes;
e) Monitoring cost-effectiveness;
f) Suitable for aggregation at the national level;
g) Contribution to monitoring of progress in implementing international and regional commitments; and
h) Contribution to reporting obligations under international and regional agreements.

The selected indicators should satisfy as many criteria as possible; poorly defined indicators may hinder a proper assessment of ICOM progress. Numerous indicators for which data sources are not readily available would make their measurement costly or impractical. On the other hand, indicators based solely on available data may not be very useful for a thorough assessment of progress.

The identification, selection, development, application and monitoring of governance performance indicators may be done incrementally: starting with available data, identifying information needs and progressively expanding the indicator system - thematically, temporally and geographically. To this end, different levels of analysis and detail may be used, distinguishing between core indicators, complementary indicators and detailed indicators (see section 3.5-Measurement of governance indicators).

Figure 3-1 Matrix of relevance of ICOM governance indicators to goals and objectives

(*note: for simplification of the matrix, the parameters of the indicators have not been included; see Table 3-1)*

Goal	Objective	G1 Coordination mechanism	G2 Legislation	G3 Environmental assessment	G4 Conflict resolution mechanism	G5 Integrated management plans	G6 Active management	G7 Monitoring and evaluation	G8 Human, technical, and financial resources	G9 Inputs from scientific research	G10 Stakeholder participation	G11 NGO and CBO activity	G12 Education and training	G13 Technology	G14 Economic instruments	G15 Sustainable development strategy
Ensuring adequate institutional, policy and legal arrangements	Ensuring the coordination and coherence of administrative actors and policies	■	■	■	■	■	■									■
	Supporting integrated managements through adequate legislation and regulations		■	■												
	Assessing the environmental impacts of policies, plans, programmes and projects	■	■		■											
	Resolving conflicts over coastal space and resources					■	■									
Ensuring adequate management process and implementation	Managing the coastline through integrated plans							■		■						
	Implementing and enforcing ICOM plans and actions								■							
	Routinely monitoring, evaluating and adjusting of ICOM efforts							■		■						
	Supporting ICOM through sustained administrative structures									■	■	■				
Enhancing information, knowledge, awareness and participation	Ensuring the management decisions are better informed by science															
	Ensuring sustained support from engaged stakeholders									■	■	■				
	Ensuring NGO and CBO involvement										■	■	■			
	Ensuring adequate levels or higher education and professional preparation for ICOM								■				■			
Mainstreaming ICOM into sustainable development: economic instrument mainstreaming	Enabling and supporting ICOM through technology, including environmentally-friendly technology												■	■		
	Incorporating economic instruments into coastal management policies														■	
	Mainstreaming coastal and ocean management into sustainable development															■

The choice of indicators will also depend on the stage of development of the ICOM programme (e.g., see Chua et al., 2003 for indicators related to the stages of programme formulation, implementation, sustainability and monitoring and evaluation), as well as the scale (e.g., national, regional, local) and spatial extent of the area being managed (e.g., coastal, EEZ).

It should be noted that much of the experience to date in the application of governance indicators has taken place in the management of coastal lands and nearshore coastal waters. Increasingly, however, as nations develop coordinated approaches to the management of the EEZ, there is a need for governance indicators relevant to management of these ocean areas. While many of the governance indicators developed for coastal management may be applied to the management of offshore areas, other variables may need to be emphasized given, e.g., the dominance of public interests in EEZs versus in coastal lands where, because of the presence of private property rights, public and private interests must be balanced.

3.5 Measurement of governance indicators

Some governance indicators can be measured at different levels of detail. The first level can provide a summary of the main issues involved. At this level, often suitable for national reporting, the indicators may largely consist of "checklists" to be answered in a binary or semi-quantitative way, e.g.:

Indicator	**2005**	**2010**
A mechanism for inter-institutional coordination is in operation	Yes/No	Yes/No

or:

Indicator	**Current status**	**Target 2010**	**Target 2015**
Coastline covered by integrated management plans (km or %)			
Under development			
In place			

The second level may focus on a qualitative assessment, e.g.:

a) Level of representation, functionality, effectiveness and sustainability of the coordinating body *(Are all the relevant agencies and stakeholders involved? Does the coordinating body meet and deliver recommendations? Are the recommendations of the coordinating body influential on coastal-related policies? Are relevant institutions supportive of the activities of the coordinating body?);*
b) Quality and implementation of integrated management plans *(What is the completeness and quality of the integrated management plan? Is the plan being implemented? Are the provisions of the plan enforced? Are stakeholders compliant with the plan?);*

The **third level** may be concerned with the provision of additional details, the measurement of **medium- and long-term changes** in the institutional setting and the measurement of outcomes and impacts on the environmental and socioeconomic dimensions, e.g.:

a) Institutional development and coherence *(Has the coordinating body influenced other sectoral policies affecting the coastal area? How has the coordinating body contributed to ensuring coherence of those policies? How has the coordinating body contributed to advancements in the ICOM policy cycle?);*
b) Effectiveness of integrated management plans (*Are integrated coastal management plans achieving their objectives? Are there visible and scientifically demonstrated signs of improvement in environmental quality?)*

A detailed description of governance performance indicators is given in Annex I.

Table 3-1 Governance goals, objectives, indicators and parameters (G1 – G15 are key indicators)

Goals	Objectives	Indicators and parameters
Ensuring adequate institutional, policy and legal arrangements	Ensuring the coordination and coherence of administrative actors and policies	Definition of functions of administrative actors • ICOM functions of administrative actors clearly defined by legislation or administrative acts • New agencies for ICOM established • Primary responsibility for ICOM mandated to a single agency
		Policy goals and objectives and strategies for ICOM • Policy goals and quantifiable objectives for ICOM formally adopted • Strategies and procedures for the implementation of the ICOM objectives developed and • formally adopted, including incorporation of ICOM principles into sectoral instruments
		G1 Existence and functioning of a representative coordinating mechanism for ICOM • Existence of a coordinating mechanism • Functioning of the coordinating mechanism • Outcomes and influence of the coordinating mechanism
	Supporting integrated management through adequate legislation and regulations	**G2 Existence and adequacy of legislation enabling ICOM** • Existence of legislation on coastal and marine resources • Adequacy of the ICOM legislation
	Assessing the environmental impacts of policies, plans, programme and projects	**G3 EIA, SEA and CCA procedures for plans, programmes and projects affecting coastal zones** • Use of EIA and SEA procedures and modifications to coastal projects • Use of CCA procedures in coastal tourism development
	Resolving conflicts over coastal space and resources	**G4 Existence and functioning of a conflict resolution mechanism** • Stakeholders and issues at stake • Agreed procedures and mechanisms for conflicts resolution • Changes in the proportion of conflicts that are mitigated, resolved, or prevented • Overall changes in the number of conflicts

(continued) **Table 3-1 Governance goals, objectives, indicators and parameters (G1 – G15 are key indicators)**

Goals	Objectives	Indicators and parameters
Ensuring adequate management processes and implementation	Managing the coastline through integrated plans	**G5 Existence, status and coverage of ICOM plans** • Existence and status of ICOM plans • Characteristics of ICOM plans • Extent (percentage) of coastline covered by ICOM plans
	Managing coastal watersheds through integrated plans	Existence, status and coverage of watershed management plans • Existence and status of watershed management plans • Characteristics of these plans • Extent (percentage) of watershed area covered by ICOM plans
	Conserving coastal and marine biodiversity through management plans	Existence, status and coverage of management plans for coastal and marine ecosystems • Existence and status of coastal/marine ecosystem-based management plans • Characteristics of ecosystem-based management plans • Extent (percentage) of coastal/marine ecosystems covered by management plans
	Implementing and enforcing ICOM plans and actions	**G6 Active management in areas covered by ICOM plans** • Level of implementation of ICOM plans, actions and projects, including infrastructure building • Procedures, legal tools and monitoring and sanctioning applied for enforcement of ICOM plans/actions • Level of compliance with ICOM plans
	Routinely monitoring, evaluating and adjusting ICOM efforts	**G7 Routine monitoring, evaluation and adjustment of ICOM initiatives** • Existence of an operational monitoring and evaluation system with related indicators • Consideration of results into ICOM initiatives • Adjustments made to ICOM initiatives
	Supporting ICOM through sustained administrative resources	**G 8 Sustained availability and allocation of human, technical and financial resources for ICOM, including the leverage of additional resources** • Staff • Budget • Facilities

(continued) **Table 3-1 Governance goals, objectives, indicators and parameters (G1 – G15 are key indicators)**

Goals	Objectives	Indicators and parameters
Enhancing information, knowledge, awareness and participation	Ensuring that management decisions are better informed from science	**G9 Existence, dissemination and application of ICOM-related scientific research and information** • Existence of research studies and scientific publications • Completion of a diagnostic assessment that identifies root causes of coastal and marine degradation and establishes priority for interventions • Existence and dissemination of a state of the coast report • Existence and functioning of a science advisory body • Existence and operation of routine monitoring of the marine environment • Inputs from scientific research and diagnostic assessment into ICOM
	Improving awareness on coastal issues	Dissemination of information on coastal issues to the public • Section on the coastal and marine environment in a regularly published state of the environment report or separate state of the coast report • Media events covering coastal issues held
	Ensuring sustained support from engaged stakeholders	**G10 Level of stakeholder participation in, and satisfaction with, ICOM decision-making processes** • Level of stakeholder participation • Level of stakeholder satisfaction with participation and with ICOM outcomes
	Supporting ICOM through partnerships	Establishment of partnerships and steering groups • Number of functional public-private partnerships created • Number of ICOM-related projects initiated as a result of partnerships
	Ensuring NGO and community involvement	**G11 Existence and activity level of NGOs and CBOs supportive of ICOM** • Existence and characteristics of NGOs and CBOs active in ICOM • Level of activity of NGOs and CBOs active in ICOM
	Ensuring adequate levels of higher education and professional preparation for ICOM	**G12 Incorporation of ICOM into educational and training curricula and formation of ICOM cadres** • Educational and training programmes incorporating ICOM • People having completed educational and training programmes in ICOM • Employment of people with education and training in ICOM

(continued) **Table 3-1 Governance goals, objectives, indicators and parameters (G1 – G15 are key indicators)**

Goals	Objectives	Indicators and parameters
Mainstreaming ICOM into sustainable development; Economic instruments mainstreaming	Enabling and supporting ICOM through technology, including environmentally friendly technology	**G13 Use of technology, including environmentally friendly technology, to enable and support ICOM** • Availability of ICOM-enabling and supporting technology at an acceptable cost • Level of use of ICOM-enabling and supporting technology in substitution of counter-ICZM technology • Level of coordination of ICZM-enabling and supporting technology
	Incorporating economic instruments into coastal management policies	**G14 Use of economic instruments in support to ICOM** • Availability of economic instruments, including environmental quality certifications, in conjunction with regulatory instruments • Level of implementation and enforcement of economic instruments
	Mainstreaming coastal and ocean management into sustainable development	**G15 Incorporation of ICOM into sustainable development strategy** • Existence of sustainable development strategy or Agenda 21 incorporating ICOM chapter • Level of implementation of ICOM chapter on sustainable development strategy or Agenda 21
Enhancing the international dimension of ICOM	Enhancing ICOM by implementing international recommendations and guidance	International recommendations and guidelines on ICOM influencing the ICOM process • Awareness of international recommendations and guidelines on ICOM • ICOM decisions influenced by international recommendations and guidelines
	Enhancing ICOM through involvement in international cooperative initiatives	Participation in international efforts related to ICOM and influence on the ICOM process • Active participation in international agreements and cooperative efforts in ICOM such as transboundary or multinational projects • Influence of such involvement on the ICOM process
	Enabling ICOM through implementation of international agreements	Ratification and implementation of legislation for international agreements relevant to ICOM • Ratio between agreements ratified and included in legislation

4 Ecological indicators

Summary of ecological goals, objectives and indicators

Goals	Objectives	Code	Indicators	Page
Organization: Conserve the ecosystem structure – at all levels of biological organization – so as to maintain the biodiversity and natural resilience of the ecosystem	Maintaining biodiversity	E1	Biological diversity	164
	Maintaining species distribution	E2	Distribution of species	169
	Maintaining species abundance	E3	Abundance	171
Vigour: Conserve the function of each component of the ecosystem so that its role in the food web and its contribution to overall productivity are maintained	Maintaining primary production and reproduction	E4	Production and reproduction	173
	Maintaining trophic interactions	E5	Trophic interactions	177
	Maintaining mortalities below thresholds	E6	Mortality	179
Quality: Conserve the geological, physical and chemical properties of the ecosystem so as to maintain the overall environmental quality	Maintaining species health	E7	Species health	182
	Maintaining water and sediment quality	E8	Water quality	186
	Maintaining habitat quality	E9	Habitat quality	192

4.1 Introduction

Coastal and marine ecosystems provide important goods (e.g., fish catch) and services (e.g., nutrient cycling) that are of significant benefit to humans. In addition to having value in their own right, healthy and optimally functioning ecosystems offer the greatest potential for maximization of social and economic benefits over the long-term.

As previously stated, the overall goal of ICOM is to maximize the economic, social and cultural benefits derived from coastal and marine ecosystems, while conserving their biophysical properties on which their health and productivity depend. Therefore, the management of human activities in coastal and ocean areas must also take into consideration the core aspects of ecosystem health. A combination of oceanographic, biological, biophysical, geological, geographical and ecological concepts and parameters can help guide scientists, ICOM managers and policy-makers when dealing with environmental issues at the ecosystem scale.

This chapter sets out an ecological framework for the examination of coastal and marine ecosystems, within which is presented a suite of indicators that can provide the information necessary to make informed decisions with respect to ecosystem health.

4.2 Ecosystem-based management

While the concept of ecosystem-based management (EBM) is often presented as inordinately complex, it can be simplified by a straightforward ecological framework in which the over-riding consideration is that of ecosystem health.

Three elements contribute to ecosystem health, and must be considered when setting ecological objectives and evaluating progress towards achieving them: biological organization, vigour and geological, physical and chemical properties of the ecosystem.

1. The **biological organization** (or structure) of the ecosystem: This is concerned with the biological diversity (or biodiversity), which may be defined as "the variety of living forms, the ecological roles they perform and the genetic diversity they contain" (Wilcox, 1984). An ecosystem has several levels of biological organization or diversity-genetic, species, community and habitat diversity.

Organization also includes the trophic structure (including complexity of food webs, age structure, symbiotic and cohabitation relationships) and the spatial distribution of the biotic components (continuous, patchy, or migratory). It is widely recognized that a higher degree of organizational complexity results in an ecosystem that is more resilient (capacity to recover from disturbances) and more resistant (tolerant of stress);

2. The **vigour** of the ecosystem: This is concerned with the productivity of the ecosystem, and relates to the energy flows within it and the interaction of the organizational components. Particular attention must be given to primary productivity, which is the basis of marine food chains, as well as to measures dealing with size (e.g., biomass) and species reproductive capacity;
3. The **geological, physical and chemical properties of the ecosystem: These abiotic properties** have an important influence on ecosystem organization and vigour. Measures related to these properties are concerned with oceanographic processes, as well as with environmental quality (e.g., water, sediment and habitat quality).

It is important to note that there are interactions and synergies among the three elements above, which determine the overall health of the ecosystem. Therefore, an EBM approach involves considering all relevant biological, geological, physical and chemical ecosystem properties, those properties that are emergent at the ecosystem level and can be therefore used to characterize the state of the ecosystem under consideration.

4.3 ICOM ecological indicators

There are two complementary approaches to EBM, which will determine the type of indicators to be used:

1. The **"top-down" approach** is based on identification of the most important ecosystem properties and components and the subsequent development of related EBM objectives, without prior consideration of the human activities that may be perturbing the ecosystem. Human activities that impact – or are suspected to have impacts on – the ecosystem must then be managed to meet these ecosystem objectives. Ecological indicators used to measure progress towards these management objectives are normally natural science-based ("hard science") indicators related to the state of the ecosystem, and not to any particular human activity. This approach relies more heavily on scientific capacity and understanding of the particular ecosystem under consideration. It needs a strong science support for data collection and treatment, i.e., the application of complex methodologies and measurements, appropriate laboratory and 'at-sea' facilities, as well as good scientific knowledge for data interpretation.
2. The **"bottom-up" approach** involves the establishment of EBM objectives based on a review of the human activities that may have significant impacts on the ecosystem, and identification of those ecosystem components or properties that may be impacted by them. Many of these activities will be land-based, and a number of them may have cumulative impacts on a particular ecosystem component or property (Annex II). The bottom-up approach is used in the DPSIR assessment framework discussed in Chapter 2.

Ideally, indicators for this approach are also "hard science" type indicators related to the particular activity, but could also be "proxy measures" (e.g., fisheries landings or catch per unit effort as a proxy for productivity). This approach is more amenable to situations where less scientific capacity exists and to the use of local/traditional knowledge.

Although each approach on its own can guide appropriate management actions and the selection of indicators, attempts should be made to combine the two approaches wherever possible (Figure 4-1). This will increase the potential for developing a suite of indicators that can be used to address both ecological and socioeconomic issues, as well as foster linkages between the relevant disciplines. In this respect, both the top-down and bottom-up approaches will be helpful because they provide methodological frameworks to translate the results from a rigorous scientific process into measures that are easily understandable, significant for stakeholders and relevant to management. This integration would also increase the acceptance of the objective(s) and of its associated management action and indicator(s) by local populations.

4.4 Selection of ecological indicators

It is critical, therefore, that ecological indicators reflect the three elements that contribute to marine ecosystem health. ICOM ecological indicators are designed to measure the condition of and trends in the state of the ecosystem, in particular in its biological organization, vigour and geological, physical and chemical properties.

This section provides a step-by step guide for the selection of ecological indicator menus that are most relevant to ICOM for both the top-down and bottom-up approaches described in the previous section.

Step 1: Delineate the ecosystem boundaries for implementing EBM

EBM is implemented on a geographic scale that is consistent with that of the coastal or marine ecosystem or eco-region (large areas of relative homogeneity in ecological systems and their components). The delineation of the eco-region is therefore an essential step before developing any management objectives and a fortiori associated ecological indicators.

Eco-region delineation should be a scientific process based on the best knowledge available, looking at large-scale natural features such as the geomorphology of the region, the influence of freshwater from large rivers and estuaries, oceanographic processes (e.g., main currents, water masses and mixing zones, sea water temperature), obvious discontinuities in patterns such as breaks in bathymetry, strong gradients in water properties, as well as biological characteristics and use of the area by marine life, (ecological assemblages, key species distributions). The eco-region may be further divided into smaller, nested management areas or units, if warranted. Natural sub-structures and ecological features observed at smaller scales, like specific seascapes, local hydrography and geomorphology, habitat types, functional areas (e.g., spawning areas) may also inform the delineation of management sub-units to further help address local environmental issues.

After the eco-region has been delineated, it is necessary to take account of other important factors, such as socioeconomic and cultural, historical and traditional use, as well as management zoning.

Step 2: Develop overall EBM goals based on the critical characteristics of the ecosystem

The concept of marine ecosystem health is based on the structural and functional properties of ecosystems that should be conserved. In this step, the main variables related to the ecosystem properties required to maintain ecosystem health are identified. This involves the development of overall goals related to the target state of the ecosystem properties or components. Goals should be consistent with the spatial scale of the ecosystem condition(s), and could be expressed as high-level narrative statements. For example, the goal to maintain biodiversity could read:

> *"Conserve the ecosystem structure – at all levels of biological organization – so as to maintain the biodiversity and natural resilience of the ecosystem"*

This statement captures the various elements that contribute to overall biodiversity. It also ensures that ICOM initiatives will contribute to the overall goal and guiding principles of the CBD, in which an ecosystem approach is central to conserving biodiversity and the sustainable use of biological resources.

While concern regarding the decline in biodiversity has previously focused mainly on species and habitat diversity, it is now widely recognized that genetic diversity is just as important. Even though it is not as easy to measure and interpret as species and habitat diversity, conserving genetic diversity should be considered an important EBM/ICOM goal.

The overall goal to maintain productivity may be expressed as:

> *"Conserve the function of each component of the ecosystem so that its role in the food web and its contribution to overall productivity are maintained"*

This statement means that activities affecting a component(s) of the ecosystem must be managed in such a way so as to not affect the role of any other component(s) required for maintaining ecosystem productivity. The natural role of ecosystem components will have to be defined when this objective and the required management actions are developed. This may be based on

historical data, if available, and if restoring the historical state (e.g., before any human activities occurred) is the objective. Alternatively, the reference state for the natural role of ecosystem components could be that at a certain period in time, not necessarily very far in the past, when the ecosystem was considered healthy based on the current knowledge.

The goal to maintain the quality of the environment may be expressed as:

> *"Conserve the geological, physical and chemical properties of the ecosystem so as to maintain the overall environmental quality, i.e., water, sediment, biota and habitat quality"*

To ensure that this goal will be met, two different but complementary categories of objectives are needed: the first deals with conserving the natural chemical (e.g., seawater salinity, nutrients and oligo-elements), physical (e.g., temperature, currents, structural habitat features) and geological properties (e.g., nature of bottom, sediment grain size, seascape integrity).

The second category of objectives focuses on physical or chemical elements such as contaminants, which contribute to the degradation of the overall quality of the environment and ultimately affect marine life. It must be noted that a natural component could also become a contaminant when its naturally occurring level is exceeded (e.g., trace metals, nutrients), or a limiting factor (e.g., dissolved oxygen) when it is depleted as a result of human impacts.

Step 3: Develop specific EBM objectives based on the overall goal statements

Based on the three overall goals, specific management objectives dealing with each of the ecosystem properties are developed. Examples of specific objectives are given in Table 4-1.

These conceptual objectives must be broken down in terms of increasing specificity ("unpacking" process) until EBM objectives can be expressed in operational terms, i.e., as narrative and/or quantitative statements, with indicators that can be routinely measured and associated reference points (sometimes called limits and targets) that can be set up based on the scientific knowledge available.

Step 4: Select indicators most suitable for monitoring ecosystem properties reflected in EBM objectives

Once the objectives have been established, selection of appropriate indicators can proceed. If the objective is specific enough, it may be possible to use a single indicator to monitor its achievement. On the other hand, several indicators can serve to monitor a high-level objective. The indicators of most relevance to the operational objective(s) are selected from among those proposed. In some cases, certain indicators are related to more than one objective (Figure 4-2), thus providing additional means of verification of progress. A set of ecological indicators and parameters are given in Table 4-1.

When selecting ecological indicators to ICOM, the aim is to develop an indicator menu specifically tailored to national/regional constraints and issues, i.e., the most pertinent approach (Top-down versus Bottom-up), while taking into consideration characteristics of "good" ecological indicators (see: Chapter 2), their significance, reliability and limits (Rice, 2003) as well as the environmental context of use (Salas et al., 2006).

Although the development or selection of ecological indicators – and associated measurements – may be influenced by the environmental conditions and management context, a set of high-level indicators relevant to EBM themes and key elements may be proposed as starting point for moving to a specifically designed suite of indicators. Detailed descriptions of these thematic indicators are given in Annex III.

4.5 Measurement of ecological indicators

This section presents some general guidance and considerations to be borne in mind when measuring and interpreting ecological indicators for management purposes.

Biological organization

Changes in ecosystem organization or structure are reflected in changes in biodiversity. A major management challenge, however, is to distinguish between the natural variability of biodiversity (or productivity) and that caused by anthropogenic pressures. In some cases, such as eutrophication of coastal areas, it may be relatively easy to correlate the observed change in biodiversity

and/or productivity with human activities through the use of indicators such as nutrient concentrations (e.g., nitrates, phosphates), dissolved oxygen levels (or biological oxygen demand), frequency of algal blooms (including harmful microalgae and biotoxins), etc. In other cases, however, it is often not easy to show good correlations because of multiple sources of impacts, the variety of resulting effects and the possibility of cumulative impacts, particularly when biodiversity changes, overall productivity or habitat quality are the primary focus.

Ecosystem vigour

Primary productivity is of great importance in assessing marine ecosystem health; its measurement is usually an integral part of coastal and marine environmental monitoring programmes. Measurements of primary productivity include the rates of production and phytoplankton quality (e.g., species composition of microalgal communities). Chlorophyll-a is a good proxy for microalgal biomass.

Good correlations also usually exist between chlorophyll-a levels and the availability of nutrients, the occurrence of phytoplankton blooms (measured by chlorophyll-a maximum peaks) and oxygen depletion (measured as dissolved oxygen concentrations or percent saturation level). Such direct relationships may be used for monitoring and addressing eutrophication issues.

The development and use of hydrodynamic models to calculate nutrient budgets, transport and dilution, as well as to predict their effects on primary production are needed to better interpret data from phytoplankton monitoring. Technologies such as satellite imaging and other remote sensing methods now make possible the development of 'real-time' images of chlorophyll-a concentrations in surface waters.

In coastal areas, the biomass and productivity of macrophyte beds (sometimes simply evaluated in terms of area coverage) are also important measurements for assessing the health of the ecosystem. Not only macroalgae and plants provide adequate habitats for a variety of fish, shellfish and invertebrate species, they also contribute significantly to the natural clean up process of coastal waters as well as coastline stabilization.

The overall productivity of higher trophic levels is usually reported from a fishery perspective (e.g., fish catch). Specific indicators can be developed from fisheries research, ecological models, or commercial fish landings data. These may also be used in an ecosystem approach to fisheries management.

Variability of oceanographic properties

Oceanographic and abiotic regime shifts and subsequent changes in biotic communities (including adaptation to environmental changes) can be good indicators of transformations that have occurred within ecosystems under stress. On the other hand, these changes may reflect natural long-term variability, and are not a consequence of anthropogenic impacts. This is complicated by the fact that a sudden shift may occur as a consequence of long-term exposure to chronic perturbations. Therefore, the natural temporal and spatial variability of the oceanographic, physical and chemical properties of the ecosystem must be taken into consideration when monitoring these characteristics.

Large-scale variability in coastal and marine ecosystems is expected to occur as a consequence of global warming and climate change, which could potentially cause irreversible changes in ecosystem properties. A number of indicators can be used to track the effects of climate change locally, e.g., sea level rise, increase in frequency and extent of extreme climatic events (storms, hurricanes, flooding) or decrease in ice cover in high latitudes.

It is very difficult – and perhaps impossible – to predict the amplitude and duration of the response of coastal and marine ecosystems to climate change. We can, however, assume that a healthy ecosystem is better able to adapt to such a change, within limits. What is unknown is at what point an irreversible shift to an alternate state will occur in response to these global changes. Climate change models are useful to explore possible impacts on ecosystems under various scenarios.

Similarly, remote sensing, new monitoring technologies, as well as global systems for collecting and sharing data (e.g., GOOS) will become useful ICOM tools as they are refined (i.e., regional focus), when the information is fully integrated (e.g., using Geographical Information Systems) and value-added products such as thematic maps and models, made available to the scientific community, including in countries where a strong science base does not yet exist.

Introduction of contaminants

Monitoring major groups of contaminants (e.g., persistent organic pollutants, hydrocarbons, heavy metals) dispersed/dissolved in the water column and/or accumulated on surface sediments provides a good indication of anthropogenic pollution pressure on the coastal and marine environment. In addition, monitoring the bioaccumulation of toxic chemicals in key groups and indicator spe-

cies at the top of the food web (e.g., predatory fish, seabirds and eggs, marine mammals, humans) provides a good indication of the cumulative impacts and degree of exposure of marine organisms, as well as of human populations, to these chemicals.

Although they are not routinely included in monitoring programmes, it is worth noting the usefulness of other eco-toxicological tools such as bio-markers, which are based on physiological responses to the presence of harmful substances in target organs, tissues or cells. These bio-markers may serve as early warning signals in relation to global contamination issues. Also of interest in coastal and marine environmental assessments is the use of toxicity bio-tests (Wells, 1999) to complement monitoring programmes. These measures can be used to assess "danger" thresholds and serve as "alarm" signals, to set standards or guidelines and refine reference points associated with ecological indicators.

Habitat loss and degradation

Habitat loss is commonly assessed by a direct measure of the area lost or an approximation of the percentage of the area lost for each habitat type, provided there were previous records as baseline to compare with. The relative coverage of protected and/or undisturbed habitats is also commonly reported and relatively easy to measure, and may serve to assess the effectiveness of management actions. On the other hand, habitat degradation is much more complex to evaluate since various degrees of degradation may be observed, from slightly altered to almost entirely lost. Habitat quality is better reflected by a series of indicators that may be already used to monitor and assess other ecosystem components or properties or to address other issues, e.g., biodiversity of benthic communities, productivity of key benthic species, physical or chemical properties of the water column, geological properties of sediment, presence of contaminants in water, and sediment or biota.

As far as coastal landscape integrity is concerned, coastal erosion, sediment transport and change in coastal landscape diversity may be useful measures to assess the impacts of coastal construction (e.g., urban development, marinas, harbours, coastal defence). Coastal human population is a common indicator of human pressure on coastal ecosystems. While this does not directly reflect the impacts, it is a good indicator for linking the ecological and socioeconomic aspects of ICOM.

The use of ecological indices

It is possible to develop ecological indices, in addition to, or derived from a selection of ICOM indicators. Ecological indices are of particular use when practitioners face a large number of indicators.

The intent of an index is to aggregate scientific information from a number of variables or indicators, using validated calculations and formulae. This helps to simplify and communicate a large amount of information on a complex feature of the ecosystem such as emergent properties that can be only measured at the ecosystem-scale, biological community or habitat. Like single indicators, indices are numerical values for monitoring the achievement of ICOM objectives and further guiding management actions, provided that they are properly designed and their ecological significance is well understood and interpreted by managers.

Ecological indices are thematic and they have been developed to 'measure' a variety of characteristics and properties for ecological assessments, e.g., the integrity of biological communities (Karr, 1981; and subsequent variations of the Index of Biotic Integrity), the species diversity (see the review of biodiversity indices by Costello et al., 2001), or the sediment quality in relation to the effectiveness of guidelines and regulations (Marvin et al., 2004).

Figure 4-1 **A general framework to combine the "Top-down" (i.e., based on ecosystem properties) and "Bottom-up"** (i.e., based on impacting activities) approaches when selecting ecological indicators for ICOM

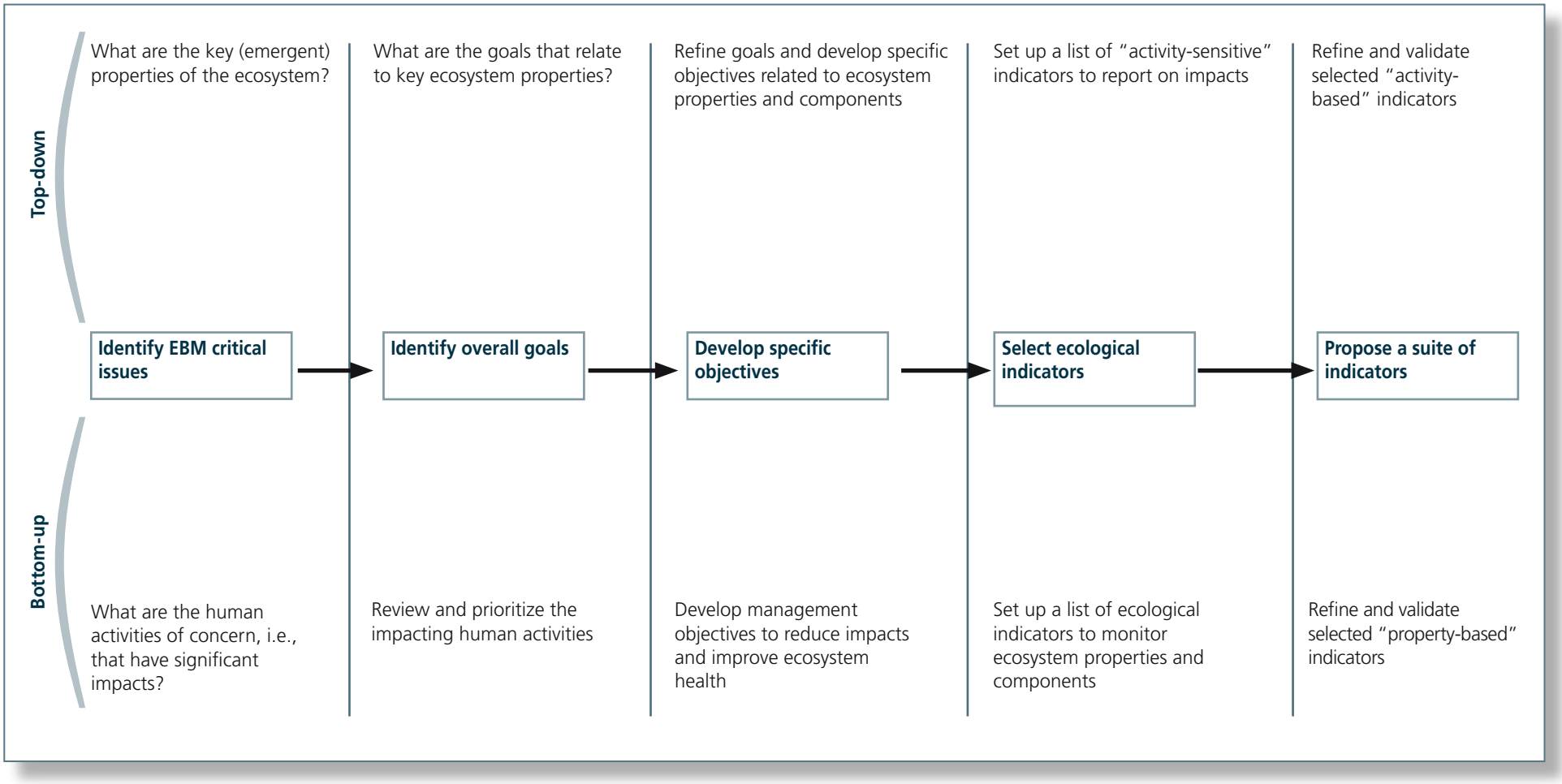


Figure 4-2 **Matrix of relevance of ICOM ecological indicators and parameters to goals and objectives**

Goal	Objective	Diversity of communities	Diversity of populations	Diversity of species	Genetic diversity	Invasive species/pests	Horizontal distribution	Biomass	Number of individuals	Density	Primary productivity	Secondary productivity	Life history stages	Reproductive parameters	Spawning survival rates	Mean generation time	Complexity of food web	Key predator/prey interactions	Keystone species	Size spectra	Fishing mortality	Incidental mortalities	Natural mortality	Species at risk of extinction	(Bio)accumulation of toxic com-	Diseases & abnormalities	Seafood quality	Water column properties	Oceanographic processes & vari-	Sedimentation	Pollutants & contaminants	Eutrophication parameters	Habitat types	Habitat alteration	Sea level change	Landscape & bottomscape integrity	Sediment quality
		E1						E3			E4						E5				E6			E7				E8					E9				
Organization: Conserve the ecosystem structure – at all levels of biological organization – so as to maintain the biodiversity and natural resilience of the ecosystem	Maintaining biodiversity				■	■																														
	Maintaining species distribution			■		■														■																	
	Maintaining species abundance	■				■	■	■	■	■																											
Vigour: Conserve the function of each component of the ecosystem so that its role in the food web and its contribution to overall productivity are maintained	Maintaining primary production and reproduction										■	■	■								■	■	■														
	Maintaining trophic interactions																■	■	■	■			■														
	Maintaining mortalities below thresholds																				■	■	■														
Quality: Conserve the geological, physical and chemical properties of the ecosystem so as to maintain the overall environmental quality	Maintaining species health																							■	■	■	■	■	■	■	■	■					
	Maintaining water and sediment quality																											■	■	■	■	■			■	■	■
	Maintaining habitat quality																																■	■			

Table 4-3 Ecological goals, objectives, indicators and parameters

Goals	Objectives	Indicator and parameters
Organization: Conserve the ecosystem structure – at all levels of biological organization – so as to maintain the biodiversity and natural resilience of the ecosystem	Maintaining biodiversity	**E1 Biological diversity** Diversity of communities Diversity of populations Diversity of species Genetic diversity Invasive species/pests
	Maintaining species distribution	**E2 Distribution of species** Horizontal distribution (patchiness, aggregation) Vertical distribution (food web/trophic structure)
	Maintaining species abundance	**E3 Abundance** Biomass (key populations) Number of individuals (marine mammals) Density (plants, benthic organisms)
Vigour: Conserve the function of each component of the ecosystem so that its role in the food web and its contribution to overall productivity are maintained	Maintaining primary production and reproduction	**E4 Production and reproduction** Primary productivity: quantity (biomass) and quality (e.g., HABs) Secondary productivity Life history stages Reproductive parameters Spawning survival rates Mean generation time (longevity)
	Maintaining trophic interactions	**E5 Trophic interactions** Complexity of food web Key predator/prey interactions Keystone species Size spectra
	Maintaining mortalities below thresholds	**E6 Mortality** Fishing mortality Incidental mortalities (by-catch) Natural mortality (predation, diseases)
Quality: Conserve geological, physical and chemical properties of the ecosystem so as to maintain the overall environmental quality, i.e., water, sediment, biota and habitat quality.	Maintaining species health	**E7 Species health** Species at risk of extinction (Bio)accumulation of toxic compounds Diseases and abnormalities Seafood quality
	Maintaining water and sediment quality	**E8 Water quality** Water column properties Oceanographic processes and variability (and regime shifts) Sedimentation (e.g., Transport of suspended sediments) Pollutants and contaminants Eutrophication parameters
	Maintaining habitat quality	**E9 Habitat quality** Habitat types Habitat alteration Sea level change Landscape and bottomscape integrity Sediment quality (nature/properties of sediments)

5 Socioeconomic indicators

Summary of socioeconomic goals, objectives and indicators

Goals	Objectives	Code	Indicators	Page
A healthy and productive economy	Maximize economic development	SE 1	Total economic value	196
		SE 2	Direct investment	*198*
	Increase employment	SE 3	Total employment	199
	Foster economic diversification	SE 4	Sectoral diversification	201
A healthy and productive environment	Minimize habitat destruction and alteration from human pressures	SE 5	Human pressures on habitats	203
	Reduce the volume of introduction of all types of pollutants	SE 6	Pollutants and introductions	204
Public health and safety	Protect human life and public and private property	SE 7	Disease and illness	205
		SE 8	Weather and disaster	207
Social cohesion	Maintain equitable population dynamics	SE 9	Population dynamics	208
		SE 10	Marine dependency	209
		SE 11	Public access	210
Cultural integrity	Maintain cultural integrity	SE 12	Traditional knowledge, innovations and practices/ Cultural integrity	211
		SE 13	Protection of coastal heritage resources	214

5.1 Introduction

Coastal and marine ecosystems support complex social, cultural and economic human systems. Among the benefits that humans derive from these ecosystems are food, raw materials, recreational and economic development opportunities, protection from coastal hazards, as well as aesthetic value.

As fisheries crises around the world have demonstrated, the social, economic, and environmental aspects of the marine environment are irrevocably linked. Fisheries are as much about people as they are about fish; the same is true for all other uses of the marine environment. The health of ecosystems, therefore, directly affects the health of economies and societies.

Thus, the ICOM process must take into account the socioeconomic importance of coastal and marine areas. While it may seem obvious, it is nonetheless worth reinforcing that these socioeconomic considerations must focus on the interaction between marine and terrestrial environments. It is this interaction between terrestrial and marine that distinguishes ICOM from other management and governance processes; ICOM indicators must capture information on this interaction. For example, ICOM indicators relevant to the economy must separate economic activity that is related to the marine environment from other activity that may be taking place in the coastal area but is otherwise unconnected to the marine environment.

Human activities have both direct and indirect impacts on the health and productivity of coastal and marine ecosystems, which in turn affect the quality of life and economies of users of coastal and marine areas. From the perspective of the DPSIR and related frameworks, effective management of anthropogenic pressures affecting the coastal zone should result in improved environmental quality and reduction of adverse impacts. This, in turn, should yield socioeconomic benefits in the longer term.

This chapter discusses the socioeconomic dimensions that should be taken into consideration in ICOM programmes, and presents a suite of indicators to evaluate the achievement of social and economic goals and objectives.

5.2 Socioeconomic considerations in ICOM

There are four broad dimensions to the socioeconomic aspects of ICOM – economic, environmental, public health and safety, and social dimensions. These are collectively united under the concept of sustainable development, which is at the centre of ICOM.

Economic dimension

Economy is what drives virtually all uses of the marine environment, so its importance cannot be overstated. There are direct economic benefits as well as costs related to sustaining lives and livelihoods and the generation of wealth in coastal and marine areas. The ICOM process should provide information to allow informed and rational decision-making with respect to the economic importance of coastal and ocean areas vis-à-vis other areas. Historically, this has not been done due to the lack of or inadequate information on the economic value of the goods and services provided by coastal and ocean ecosystems.

ICOM should also provide an economic basis for comparison of the economic value of one activity relative to another. For example, in many, if not most instances, historic and traditional use is given preference over new or non-traditional use. This preference is often made without informed consideration of the economic contribution of one activity in relation to another. ICOM could provide the basis for such comparisons, thereby facilitating what is referred to as "best use" decision-making. It can also provide valuable information on economic diversification. Economic diversity reduces the risk of economic collapse (with attendant social consequences), and can also be important in reducing ecological impacts.

ICOM should also provide information on the economic costs associated with a particular activity. While some of these costs are indirect and difficult or impossible to quantify (e.g., the opportunity costs of choosing one use over another; management and administration costs), others are easily quantifiable. These costs may significantly affect the net economic value of an activity. For example, the cost of research and management of sustainable commercial fisheries may be significant (up to or beyond 50% of the economic value of the activity), whereas that for a recreational fishery for the same species might be significantly lower. This interaction should also be captured in ICOM goals and objectives.

Environmental dimension

A healthy and productive environment is a fundamental aspect of the concept of sustainable development, and plays a central role in ICOM. As a general statement, an overall goal of any ICOM process should be to ensure that development of coastal and marine areas is environmentally sustainable, that their resources remain viable and that the interaction between coastal biophysical dynamics and human uses of the environment be understood and managed in an integrated manner.

From a socioeconomic perspective, there are both direct and indirect environmental costs associated with income-generating activities, as well as with the effects of population and development in coastal areas. The indicators presented in this chapter provide information on these human interactions with the environment. They complement the ecological indicators presented in Chapter 4. Ecological indicators focus primarily on the status (and trends) in the state of the coastal and marine ecosystem(s). The environmental indicators in this chapter, however, focus on the human activities in the coastal and marine environment that will affect the ecosystem state. Thus, they deal with the issue from a very different, but complementary, perspective. The environmental indicators in this chapter are also particularly complementary to the process described in Chapter 4 with respect to the "bottom-up" approach to examining the marine environment.

There is also a direct link between the environmental dimension and the public health and safety dimension, particularly with respect to the introduction of pollutants to the marine environment, which can affect water quality and result in human impacts (e.g., illness from bathing and consumption of contaminated seafood).

Public health and safety dimension

The oceans affect human health through both the ocean-climate system and physical-biological-chemical processes within coastal and marine ecosystems that store, distribute and concentrate human pathogens and toxic chemicals.

There is increasing concern about the growing number of diseases and infirmities associated with contaminated seawater, fish and other marine species. Risks to human health arise from the consumption of contaminated seafood, as well as contact with poor quality water, e.g., through recreation (GESAMP, 2001). This can lead to significant economic losses for seafood industries, fishing communities, trade, travel and tourism. Shuvall (2001) estimated the global disease burden and associated costs of consuming raw or lightly steamed shellfish from waters contaminated with wastewater and natural marine biotoxins. Preliminary estimates suggest that economic losses are on the order of USD16 billion annually. Although high, this estimate is not inconsistent with similar estimates at smaller scales. For instance, an analysis by Bowen and Terkla (1990) suggests that the cost of seafood-borne disease in Massachusetts, U.S.A. (population about 6 million) is in the order of USD 60 million annually. Scaling this up to the global population gives an estimate of about USD 60 billion. Although such estimates are rough, they illustrate that the potential socioeconomic value of an integrated management and ocean observing system significantly exceeds the required investment.

The distribution of (and human exposure to) waterborne contaminants depends on interactions between human activities (e.g., sewage discharge, swimming, seafood consumption), ocean circulation and distribution of marine organisms, as well as the weather (NRC, 1999). Global weather patterns, such as those associated with El Niño Southern Oscillation (ENSO), have been shown to increase the incidence of diseases such as malaria and cholera in tropical and sub-tropical regions, where coastal populations are at most risk (Epstein, 1996; NRC, 1999).

These realities underscore the importance of developing an integrated approach to monitoring and controlling public health risks in the coastal zone. This should encompass the effects of ocean processes on the distribution and abundance of human pathogens and toxic agents (Knap et al., 2001), as well as the impacts of land-based activities.

Coastal populations are impacted by a variety of natural hazards, relative to space-time contexts, including erosion, saltwater intrusion, subsidence, tsunamis and floods due to both storm surges and swollen rivers. Exposure to such natural hazards is expected to increase due both to increases in population density in low-lying coastal areas and the effects of global climate change (e.g., sea-level change and possible increases in the frequency of extreme weather such as tropical cyclones). ICOM approaches can support the mitigation of exposure to these hazards.

Social dimension

Cultural and aesthetic value

Communities and individuals also have important social and cultural dependencies on the coastal and marine environment, including landscapes/seascapes, material cultural heritage and traditional knowledge, innovation and practices. Cultural and aesthetic values often transcend the view of nature as a collection of marketable objects. Natural systems hold intrinsic values that can only be articulated in their contribution to social, cultural, psychological and aesthetic needs. It is only through this recognition that a complete assessment can be made of their value to society.

Population dynamics

One of this century's most intriguing and important population trends has been human migration to the coast. Indeed, the present population of coastal areas exceeds the total global population of just fifty years ago (Bowen and Crumbley, 1999). Rigorously constructed estimates vary widely, but it can be safely assumed that between one-quarter and one-half of the global human population lives within the coastal zone (Hinrichsen, 1998; GESAMP, 2001; Shuvall, 2001; NOAA, 2005). The most rigorous assessment to date gives an estimate at the lower end of this range. However, it combines various data sources for a common base year (1990), meaning that this estimate does not include recent migration toward the coast (Small and Nichols, 2003).

In some instances, population growth rates (from both migration and indigenous growth) in coastal areas are several times greater than national growth rates (NOAA, 1998). This coastal migration also represents a significant cultural transformation. Most of this migration also represents a move from rural to urban environments. Today, 14 of the world's largest cities are coastal. The descriptor "megacities" characterizes cities with populations in excess of 10 million and the unique problems, including environmental, that evolve from them (World Bank, 1992).

The concentration of human population in coastal cities is well illustrated by China. In a country of nearly 10 million km^2, close to 60% of the population lives in 12 coastal provinces, along the Yangtze River valley and in two coastal municipalities – Shanghi and Tianjin (Hinrichsen, 1998).

These trends not only mean an increased absolute population, but also high population densities in the coastal cities. For instance, along the Chinese coast, population densities average between 110 and 1,600/km^2, with Shanghi having densities above 2,000. Many of the environmental stressors imposed on coastal systems result from high population densities.

The ICOM process should ensure that population dynamics and culture values are considered and their implications are linked to our understanding of their potential impacts on coastal and ocean ecosystems.

5.3 Socioeconomic indicators

Many of the goals and objectives of ICOM relate to socioeconomic aspects such as livelihoods, food security, human health, monetary, and other benefits. Socioeconomic indicators provide a useful means to represent the human component of coastal and marine systems, as well as a useful tool in the development of ICOM strategies and projects. They are used to report and measure human activities and conditions in the coastal zone, and to assess the socioeconomic impacts of ICOM efforts.

Socioeconomic indicators allow ICOM managers to: (i) incorporate and monitor the concerns and interests of stakeholders in the management process; (ii) evaluate the impacts of management decisions on stakeholders; (iii) demonstrate the socioeconomic value of coastal and marine areas and their resources; and (iv) assess the costs and benefits of using coastal and marine areas and their resources.

The suite of suite of indicators presented in this chapter relate specifically to the goals and objectives that are set out at the start of this chapter. It is important to note, however, that these indicators could nonetheless be used to track progress toward a different set of objective statements, as long as those objectives are within the same general categories.

Economic indicators

Regardless of the specific goals and objectives of any particular ICOM project, there are three key indicators which provide relevant information from and economic perspective for ICOM:

- Total economic value: includes both gross value and net value (value added), and should be determined for all marine-related activities in the ICOM area
- Total employment: includes both economic value of employment and the number of persons employed; and
- Direct investment: includes private sector investment, public sector investment and direct foreign investment.

These three indicators are "companion indicators", each providing a complementary picture of the marine-related economic activity in the ICOM area. To be most effective, each of these indicators should be developed for the following main categories in order to provide a comprehensive picture of the economy of the ICAM area:

1) For the coastal zone (that is, land-based activities dependent on the marine environment), e.g., fish and seafood processing; tourism and recreation (local and visitors); port and shipping (people and goods) activities, including ship-building; other activities that are "water-dependent".
2) For the marine environment (out to the boundary of the EEZ or the continental shelf):
   a) Living resource exploitation, e.g., fishing (commercial, recreational, artisanal); aquaculture and mariculture; marine plant harvesting; pharmacological or genetic.
   b) Non-living resource exploitation, e.g., offshore oil and gas industry; sand, gravel and mineral (e.g., salt) extraction.
   c) Non-consumptive use, e.g., electricity generation from wind, tidal or wave energy.

Environmental indicators

As discussed previously in this chapter, the environmental indicators, from a socioeconomic perspective, focus on human activity in the ICOM area. An underlying concept is that human activities in the coastal zone should be managed; at the very least, the potential for negative effects should be examined. Implicit in the concept of management is that management plans for human activities (such as fisheries management plans) are based on an implicit or explicit analysis of the effects of that activity on the marine environment. While one element is focused on the collection of information on the proportion of human activities that have management plans, it is recognized that not all activities have management plans. In this case, information should be collected on other actions that provide an assessment of the impact of the activity, e.g., a project EA or SEA.

Other particular environmental management objectives that may be considered in this context of managing human activities include:

- Minimization of human impacts such as habitat loss/fragmentation (especially in biologically sensitive and productive areas), loss of permeable surface and groundwater depletion by changes in land use/land cover patterns and authorized use of the coastal and marine environment;
- Minimization of changes to coastal storm protection (loss of natural barriers such as coastal wetlands and sand dunes) by physical alteration to the coastline;
- Physical alteration of the benthic environment (e.g., though dredging or dumping, or through bottom-trawling or other benthic impact fishing practices) should be done in consideration of cost-benefit analysis that includes the long-term and secondary impacts directly or indirectly associated with the disturbance.

Public health and safety indicators

An overall objective of ICOM is that public health and safety risks directly or indirectly associated with land-based, coastal and ocean activities are reduced. As indicated previously, many aspects of public health and safety are closely related to the environmental dimensions, particularly related to:

- Minimization of point and non-point sources of pollutant discharges to coastal and ocean areas; and
- Separation of treatable and non-treatable pollutants, and removal of non-treatable pollutants from the discharge, where discharges are made or authorized.

Additionally, it is also necessary to monitor natural sources of harmful toxins. It is generally accepted that public and private infrastructure in the ICOM area should be positioned so as to minimize human and public health and safety risks associated with the marine environment. As recent events ranging from weather related disasters to tsunamis arising from marine earthquakes have so tragically demonstrated, the impact on human lives, property and livelihoods can be enormous.

Two indicators (Annex IV) are suggested for tracking the socioeconomic consequences associated with these or similar objectives:

- Disease and illness: a measure of the extent to which human health has been negatively affected by the water and species quality in the marine environment; and

- Weather and disaster: a measure of the extent to which human lives and property are affected by weather and marine disaster events.

Social cohesion and cultural integrity indicators

As part of the broader social dimension, population dynamics must be given particular focus because of its important effects on coastal areas. Understanding the importance of the human linkage to the coastal and marine environment is important for overall management purposes, and for creating within the population (and governments) an empirical sense of the importance of the area. It should also be noted that the distribution and changes in population density and in the composition of the population can be as important, or more important than, the total population. There are two important trends that should be considered: on the one hand, the spread of population into previously uninhabited areas can increase the destruction and fragmentation of coastal habitats, contaminate coastal waters with a variety of pollutants and subject new resources to exploitation; on the other hand, the dynamics of urban growth and concentrated urban sprawl bring with them a series of very different social, economic and environmental challenges that ICOM managers need to consider and deal with.

It is also important that the ICOM process considers the social attachment to the marine and coastal environment – in effect, the intrinsic "value" that the population derives from the marine environment. This includes the historical connection to the marine environment (e.g., the number of generations families have lived in proximity or connected to the marine environment), but will also include concepts such as the extent of access that the population has to the marine and coastal area – either physical access or access to the resources.

The incorporation of traditional ecological knowledge into the ICOM process, and whether the ICOM process is accessible to the local population from a linguistic perspective (e.g., meetings held in the language of the local population; documents produced in a language used by the local population) are also important considerations.

Some relevant indicators that are presented on these dimensions are marine dependency; public access; traditional knowledge and practice; and, protection of coastal heritage resources.

5.4 Selection of socioeconomic indicators

Because ICOM is based on the concept of sustainable development, the selection of socioeconomic indicators should relate to each of the pillars of sustainable development – economic, environmental, and social/cultural dimensions. ICOM socioeconomic indicators are designed to measure the condition of and trends related to the human component of the ecosystem, including the economic and social benefits humans derive from the ecosystem and the stresses that human activity places on the ecosystem in pursuit of those benefits.

Socioeconomic indicators should:

- Provide information on either a cost or a benefit basis, i.e., the cost of an action or inaction, or the benefit derived from taking an action, or both;
- Include both direct and indirect societal costs and benefits ("externalities"); and
- Be amenable to providing and tracking information on both long-term and short-term costs and benefits.

This section provides a step-by step guide for the selection of socioeconomic indicators that are most relevant to ICOM.

Step 1 Delineate the boundaries

To be most effective, the socioeconomic indicators should relate to the same management unit or area as the governance and ecological indicators. Some of the factors that need to be considered in all cases include scientific determination of the ecological region(s) – oceanographic and biological characteristics – relevant legal and political boundaries, boundaries of historical and traditional use, as well as management zoning. Another important consideration may be boundaries used for existing data collection processes, since reliable data are required to support the ICOM process and the development of relevant indicators.

Step 2 Identify the critical parameters that characterize the socioeconomic environment

Each ICOM area will have a unique combination of human activity. However, ICOM managers should consider the general classification system for economic

activities (land-based activities and marine-based activities) described above for identifying the critical parameters that define the socioeconomic environment. The activities that are taking place in the ICOM area can then be placed into this general scheme. For some of the social components, the best way of characterizing the area may be area-based rather than activity-based; many of the social indicators relate to nature as well as trends in population distribution.

Step 3 Build goals and objectives through an integrating and engagement process

The selection of a final priority list of indicators should begin with an established set of goals and objectives. These goals and objectives are developed with the synergies between socioeconomic and coastal and marine environmental dynamics in mind.

It is important to engage the stakeholder community in setting the programme goals and objectives and to assess their preferences with respect to the value of individual indicators in measuring progress towards achieving these goals. The process may be designed to develop a ranking of the most important indicators that can be used to evaluate measures of change in, and therefore, the level of success in meeting socioeconomic goals.

The process begins with the articulation of three lists:

List 1. describes the regional stakeholder community with a vested interest in ICOM programme success. The classification approach described in Step 2 will facilitate the development of this list;
List 2. articulates both the overall goals and more precise and measurable programme objectives;
List 3. gives details of candidate indicators to detect achievement of programme goals.

With the three lists in hand, several questions are addressed in linking vested stakeholders and programme goals and the relationship between indicators and goals:
For the goal/objective setting stage:
Which goals and objectives best reflect the aspirations of citizens and residents of this area, and over what time frame?
Which goals and objectives best reflect the aspirations of users of the coastal and marine environment, and over what time frame?
Which of these goals is most important in meeting stakeholder interests and needs?
The summary table at the start of this chapter provides examples of the types of goals and objectives that may be considered.

Step 4 Identify indicators that measure change in the objectives

Indicators of critical socioeconomic change need to be identified and linked to the goals and objectives of the ICOM programme. In some cases, certain indicators are related to more than one objective (Figure 5-1), thus providing additional means of verification of progress.

Some relevant questions to help guide the selection of indicators include:
Which indicator will best allow measurement of change in this programme goal?
Which indicator provides the greatest value to the largest number of stakeholders?
For the indicator development stage:
What are the parameters of most relevance to the local circumstances and for which data are available, or for which a data collection process could reasonably be instituted?

A menu of socioeconomic indicators and their parameters are given in Table 5-1. Further details on these indicators are described in Annex IV. These indicators can be adapted to local circumstances.

Step 5 Rank indicators that provide the greatest value to a broad number of objectives

All efforts in integrated management will face varying degrees of financial or human resource constraints. Given the complexity of the issues faced by managers, the need to prioritize indicators appears clear. Scarce resources should be expended on those indicators producing the greatest value to the broadest number of needs. Socioeconomic indicators should also be ranked according to the total value they provide to the stakeholder community. The aim is to develop an indicator menu specifically tailored to the national, regional and local constraints and issues.

This approach for the selection of indicators represents the confluence of several international efforts that share the same goals as this guidebook. In particular, the effort to rank indicators in order to maximize value to the user community and to enhance the sustainable management of coastal systems is drawn from work first proposed by the Coastal Panel of the Global Ocean Observing System (IOC, 2003b; IOC, 2005). Refinements to this approach and initial efforts to establish a means to incorporate socioeconomic indicators is available on the Internet (http://www.phys.ocean.dal.ca/~lukeman/COOP/). The effort to establish specific indicators based on the DPSIR framework draws on the results of the international workshop (The Role of Indicators in Integrated Coastal Management) held in Ottawa during 2002. These initiatives illustrate the continuity of effort and approach that is needed for general acceptance of the use of indicators in coastal management.

5.5 Measurement of socioeconomic indicators

Detailed information on measurement of individual indicators is provided in the information sheets for each indicator in Annex IV. There are, however, some general observations with respect to socioeconomic indicators that should be considered and are discussed below.

Availability of Information: Unlike scientific data required for many of the ecological indicators, or new surveys that may be required to collect information for governance indicators, one of the unique aspects related to the development of socioeconomic indictors (particularly the economic dimension) is that the basic information is usually already available (most often collected by government agencies). Thus, the challenge is not the availability of information, but access to existing information, and compiling that data in a way that is most useful to the ICOM process. For social indicators, however, it is less likely that the information will be readily available and will often require new data collection efforts.

"Rolling up" information: In recent years, several countries have embarked on national indicator projects, often dealing will social, economic and environmental indicators relevant to the ICOM process. In designing ICOM indicators suites, consideration should be given to how local and regional ICOM indicators can be fitted into these larger national efforts. Wherever practicable, local/regional ICOM indicators should be constructed so that the information can be rolled-up for reporting at the national level (including to be compatible with multiple ICOM initiatives within the country.)

Distinguishing the ICOM area: A basic premise of ICOM indicators is that they should distinguish the coastal and ocean areas from other areas within the country or region. This will allow comparisons at several levels, e.g., between the ICOM activities and other non-ICOM related activities in the local/regional level, and for the ocean and coastal area of a country generally in relation to the overall national accounts to the total economy.

Participation/Buy-in/Utility: Because in many cases ICOM managers will be dependent on data from stakeholders and users of the coastal and marine environment, securing their active participation in the process at the outset will facilitate subsequent data collection efforts. Moreover, the participation of stakeholders will help ensure that the effort of developing and using indicators will be focussed on those indicators that have the greatest utility to the greatest number of people.

Display and distribution: While many indicators rely on numerical data for their construction, the information should be transformed into graphical and visual displays wherever possible in order to facilitate analysis and understanding of the information that is presented. In particular, internet-based mapping techniques can be very effectively (and cost-effectively) used for many of the socioeconomic aspects related to population distribution and dynamics.

Figure 5-1 **Matrix of relevance of ICOM socioeconomic indicators to goals and objectives**

Goal	Objectives	Value of living resources	Value of non-living resources	Non-consumptive uses	Economic value-added	Value of exports	Management & administration costs	Investment by government	Private sector investment	Foreign direct investment	Number employed	Employment payroll value	Same sub-categories as total economic value	Land-based activities dependent on the marine environment	Activities in the ICOM area out to the boundary of the EEZ or the continental shelf	Non-living resource exploitation	Non-consumptive use	Land use/land cover patterns & composition	Population density	Extent of hard-surface areas	High-impact fishing gear/practices	Dumped & dredged material	Population served by wastewater treatment	Volume, no. & type of point-source discharges	Non-point-source nutrient loading	Discharged sediments and nutrients	Volume of ballast & bilge discharge	Litter & debris
		SE 1						**SE 2**			**SE 3**			**SE 4**				**SE 5**					**SE 6**					
A healthy and productive economy	Maximizing economic development	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■											
	Increase employment							■	■	■	■	■	■		■													
	Foster economic diversification	■	■	■				■	■	■	■	■	■															
A healthy and productive environment	Minimize habitat destruction and alteration																	■	■	■	■	■	■	■	■	■	■	■
	Reduce the volume of introduction of all types of pollutants																		■			■	■	■	■	■	■	■
Public health and safety	Protect human life and public and private property																											
Social cohesion	Maintain equitable population dynamics													■	■													
Cultural integrity	Maintain cultural integrity																											

Figure 5-1 **Matrix of relevance of ICOM socioeconomic indicators to goals and objectives (*continued*)**

Goal	Objectives	Fecal coliform counts	Days of beach closure	Extent of contaminated species	Extent of contaminated water	Seafood-transmitted illnesses	Economic value of loss from marine weather	Lives lost from weather & marine disasters	Resident & total (seasonal) population	Degree of public access	Economic dependency	Social dependency	Physical access	Economic access	Linguistic diversity	Traditional land & water tenure	Lands & waters managed or co-managed by	Movement away of indigenous and local com-	Establishment & implementation of favorable	Access to traditional coastal & marine resource	Manifestations of traditional knowledge	Number & type of coastal heritage resources	Percentage of coastal heritage resources that are	Percentage of coastal heritage resources that are	Use of cultural heritage resources & most visited
		SE 7					**SE 8**		**SE 9**		**SE 10**		**SE 11**		**SE 12**							**SE 13**			
A healthy and productive economy	Maximizing economic development													■											
	Increase employment													■											
	Foster economic diversification													■											
A healthy and productive environment	Minimize habitat destruction and alteration												■												
	Reduce the volume of introduction of all types of pollutants																								
Public health and safety	Protect human life and public and private property	■	■	■	■	■	■	■																	
Social cohesion	Maintain equitable population dynamics								■	■		■	■												
Cultural integrity	Maintain cultural integrity													■	■	■	■	■	■	■	■	■	■	■	■	■

Table 5-1 Goal, objectives and socioeconomic (SE) or Quality of life indicators and parameters

Goals	Objectives	Indicators and parameters
A healthy and productive economy	Maximize economic development	**SE 1 Total economic value** • Value of living resources • Value of non-living resources • Value of non-consumptive uses • Economic value-added • Value of exports • Management and administration costs
		SE 2 Direct investment • Investment by government • Private sector investment • Foreign direct investment
	Increase employment	**SE 3 Total employment** • Number employed • Employment payroll value • Same sub-categories as total economic value
	Foster economic diversification	**SE 4 Sectoral diversification** • Land-based activities dependent on the marine environment • Activities in the ICOM area out to the boundary of the EEZ or the continental shelf • Non-living resource exploitation • Non-consumptive use
A healthy and productive environment	Minimize habitat destruction and alteration from human pressures	**SE 5 Human pressures on habitats** • Land use/land cover patterns and composition • Population density • Extent of hard-surface areas • High-impact fishing gear/practices • Dumped and dredged material
	Reduce the volume of introduction of all types of pollutants	**SE 6 Pollutants and introductions** • Population served by wastewater treatment • Volume, number, and type of point-source discharges • Non-point-source nutrient loading • Discharged sediments and nutrients • Volume of ballast and bilge discharge • Litter and debris

Table 5-1 Goal, objectives and socioeconomic (SE) or Quality of life indicators and parameters (*continued*)

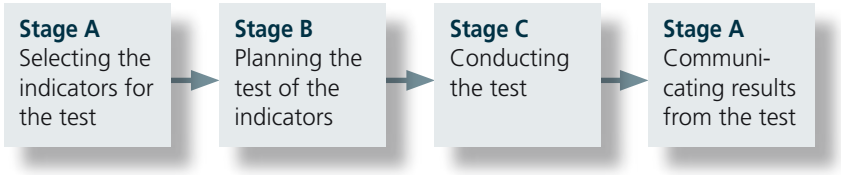
Goals	Objectives	Indicators and parameters
Public health and safety	Protect human life and public and private property	**SE 7 Disease and illness** • Fecal coliform counts • Days of beach closure • Extent of contaminated species • Extent of contaminated water • Seafood-transmitted illnesses
		SE 8 Weather and disaster • Economic value of loss from marine weather-related events • Lives lost from weather and marine disasters
Social cohesion	Maintain equitable population dynamics	**SE 9 Population dynamics** • Degree of public access • Resident and total (seasonal) population
		SE 10 Marine dependency • Economic dependency • Social dependency
		SE 11 Public access • Physical access • Economic access
Cultural integrity	Maintain cultural integrity	**SE 12 Traditional knowledge, innovations and practices / cultural integrity** • Linguistic diversity • Traditional land and water tenure • Lands and waters managed or co-managed by indigenous and local communities • Movement away of indigenous and local communities • Establishment and implementation of favourable government policies and programmes • Access to traditional coastal and marine resource rights • Manifestations of traditional knowledge
		SE 13 Protection of coastal heritage resources • Number and type of coastal heritage resources identified and assessed • Percentage of coastal heritage resources that are protected • Percentage of coastal heritage resources that are vulnerable or being damaged because of natural and human factors • Use of cultural heritage resources and most visited sites

6 Applying
the indicators

6.1 Introduction

This chapter provides a practical guide to test the indicators proposed in the previous chapters. The guide builds upon the approach outlined in Pomeroy et al. (2004, p. 1-44) and provides four stages for conducting the test (Figure 6-1). The application of this guide is illustrated using the test case studies.

Figure 6-1 Steps in the implementation of the ICOM indicators test



Summary of test case studies

The location of the study areas is shown on the map in Figure 6-2.

- Canada, Eastern Scotian Shelf Integrated Management (ESSIM) Initiative (Lead agency: Department of Fisheries and Oceans)

The ESSIM Initiative was launched in 1998, and encompasses an area of approximately 325,000 km^2, extending from 12 nautical miles to the Canadian EEZ. The ESSIM Initiative is a collaborative ocean management and planning process being led and facilitated by the Department of Fisheries and Oceans, Canada (DFO) under Canada's Oceans Act. The primary aim is to develop and implement an Integrated Ocean Management Plan for this large marine region. This multi-year, strategic level plan will provide long-term direction and a common basis for integrated, ecosystem-based and adaptive ocean management. The ESSIM planning process involves a broad range of interests, including government, First Nations, ocean industry and resource users, environmental conservation groups, coastal communities and university researchers. (Walmsley and Arbour, 2005).

- Chile, National Policy for the Coastal Fringe (Lead agency: Undersecretary of the Navy)

Chile entered a new stage in management of its coastal and maritime areas through the National Coastline Use Policy control of the Chilean littoral, effective through Executive Order N° 475 of 1994. This instrument created a decision-making authority that embraces several public and private actors dealing coastal concerns. It also incorporates the concept of management decentralization to establish a zonation in the regional use of coastal areas through the development of a territorial planning process that includes the spatial expression of economical, social, cultural and environmental policies. Natural conservation areas, cultural heritage and danger zones are also considered. This territorial planning allows for the sustainable exploitation of natural resources and for the harmonious development of tourism, and industrial and economic activities. (National Commission on the Use of the Chilean Coastline, 2006).

- China, Xiamen ICM Project (Lead agency: Xiamen Ocean and Fisheries Bureau)

Before the 1980s, large-scale reclamation of nearshore areas in Xiamen significantly altered its coastal environment. In the 1980s, the State Council of the People's Republic of China declared Xiamen a Special Economic Zone. Subsequently, the socioeconomic growth of Xiamen Municipality increased due to its policy of building Xiamen into "a modern, international, maritime and scenic city". This policy has set new requirements for the use and management of Xiamen's natural resources, particularly its coastal lands and waters. The project was operationalized in 1994 with the Xiamen Municipal Government as the lead implementing agency and the Marine Management Division as the operational arm. (Xiamen Taskforce of the Application of the IOC Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management, 2006).

- France, Thau Lagoon Integrated Management Project GITHAU (Lead agency: IFREMER)

The Thau Lagoon is a Site of Community Interest (UNESCO World Heritage site) and represents a fragile and rich coastal lagoon system characterized

Figure 6-2 Location of the study areas

by numerous human activities (e.g. oyster and mussel culture, artisanal fisheries, tourism, shipping, urban development, vineyards, industry, thermalism). Management involves various issues such as environmental protection, economic development and social equity, unsustainable pressures (such as wastes, watershed contamination), development of human activities, public ignorance about the ecosystem, as well as the implementation of management tools. IFREMER's approach to the testing of indicators does not depend only on a scientific approach and involves all coastal stakeholders. The work plan is based on the inventory and analysis of available indicators.

- Denmark/Germany/Netherlands, Trilateral Wadden Sea Cooperation (Lead agency: Wadden Sea Common Secretariat)

Denmark, Germany and the Netherlands share the Wadden Sea, which is the largest unbroken stretch of mudflats worldwide, characterized by a highly productive ecosystem and the passing of 10-12 million migratory birds through the area. The key elements of the Trilateral Conservation and Management initiative are:
(a) Joint Declaration, 1982;
(b) Ecosystem Approach – Guiding principle;
(c) Joint Policy and Management Plan; and
(d) Trilateral Monitoring and Assessment Programme (TMAP).

The Wadden Sea Forum (2001) and the Sustainable Regional Development Perspective aim at the integration and implementation of sectoral strategies, the integration of the Wadden Sea and the mainland, cooperation with responsible authorities, harmonization of rules and regulations, as well as the involvement of all the stakeholders. (Jong, 2006).

- Germany, Research for an Integrated Coastal Zone Management in the Oder/Odra Estuary Region Project (ICZM-Oder) (Lead agency: Baltic Sea Research Institute)

The project started in May 2004 and is supported by the Federal Ministry of Education and Research Germany (BMBF). It represents one of two national German reference projects on Integrated Coastal Zone Management (ICZM). In 2002, the environmental minister of the federal state Mecklenburg-Vorpommern, Germany, and the vice-marshall of the Vojevodship Western Pommerania, Poland, signed the Regional Agenda 21 "Oder Lagoon". This Regional Agenda 21 mentions coastal zone management explicitly as a major topic of cooperation and forms the conceptual and spatial basis for this project.

The research area comprises the district Uecker-Randow and Ostvorpommern, and is also the eastern part of the planning region Vorpommern. It extends from 30 – 60 km inland to the the inshore coastal waters and seawards to a distance of 12 nautical miles. ICZM-Oder follows the European Water Framework Directive (WFD) of 23 October 2000. (Schernewski et al., 2006).

- Tanzania, Marine and Coastal Environment Management Project (MACEMP) (Lead agency: National Environmental Management Council)

The Tanzania Marine and Coastal Environment Management Project aims to strengthen the sustainable management and use of the EEZ, territorial seas and coastal resources, resulting in enhanced revenue collection, reduced threats to the environment, better livelihoods for participating communitiesin the coastal districts, as well as improved institutional arrangements. The project consists of the following objectives:

1) Establish and implement a common governance regime for the EEZ, which will contribute to the long-term sustainable use and management of its resources;
2) Establish and support a comprehensive system of managed marine areas in the Territorial Seas, building on ICM strategies that empower and benefit coastal communities;
3) Empower coastal communities to access opportunities to request, implement and monitor sub-projects that contribute to improved livelihoods and sustainable marine ecosystem management; and
4) Provide efficient project implementation services.

- Thailand, Coastal Habitats and Resource Management (CHARM) Project (Lead agency: CHARM EU Team)

The CHARM project is a Thai government project supported by the EU, with two pilot areas covering 5 provinces on the Andaman Sea and the Gulf of Thailand. The project began in November 2002. The coastal co-manage-

ment framework and procedures in the two pilot areas are designed and established so as to be replicated elsewhere in the country. Key habitats and resources of the project areas are mangroves, seagrass beds and coral reefs. The overall objectives of this project focus on the sustainable use of coastal habitats and resources through institutional strengthening at different governance levels, as well as through coordinating sectoral policies. Local government agencies are given the required financial resources. (Henocque and Tandavanitj, 2006).

6.2 Stages in the application of the indicators

Each stage consists of a series of steps and tasks, and is accompanied by checklists to verify progress, as well as by worksheets and examples from the test case studies to assist with the completion of the tasks (Table 6-1). Some of the steps will require specific decisions to be taken before undertaking the next step; others will allow a more flexible approach.

STAGE A – SELECTING THE INDICATORS FOR THE TEST

Stage A is concerned with the selection of the indicators based on the goals and objectives of the programme or project under evaluation, the conceptual framework used for evaluating the programme, as well as on the feasibility of individual or groups of indicators
Programme or project advancement and achievement of results in relation to goals and objectives may be examined in relation to different types of evaluation and through different conceptual frameworks and programme logic. Key types of evaluation include:

- Performance evaluations, focusing on achievements in relation to stated goals and objectives;
- Management capacity evaluations, focusing on the adequacy of institutional structures; and
- Outcome evaluations, focusing on the intended and unintended programme impacts.

Box 6-1 Types of conceptual frameworks and their characteristics for monitoring and evaluation

Framework	DPSIR	Policy cycle	Logical framework	Outcome-based approach	Ecosystem-based approach
Objective	To explore relationships between human activities and the environment	To follow project implementation	To improve programme implementation	To enhance programme effectiveness	Identification of the most important ecosystem properties and components
Focus	Environmental consequences of human activities	Progression from preparation to initiation, implementation, evaluation and adjustment	Progression from inputs and processes to outputs, outcome and impacts	Environmental, socioeconomic, and institutional changes, intended or unintended, attributable to a programme	Ecosystem properties and impacting activities
Methodology	Environmental monitoring	Internal monitoring	Internal monitoring, evaluations	External evaluations	Top-down and bottom-up approaches
Conduct	Periodic	Continuous and systematic; program management	Continuous and systematic; programme management	Periodic and in-depth; external evaluations	Periodic
Users	Policy-makers, general public	Project managers	Project managers	Project managers, beneficiaries	Project managers

Depending on the objectives and the time of their conduct, evaluations can be further classified as formative evaluations, carried out during the development or improvement of a programme for possible adjustments, and summative evaluations, carried out to determine the efficacy of a programme at its conclusion.

The conceptual frameworks used for monitoring and evaluating programmes and projects determine the type and focus of the indicators. The main conceptual frameworks — often used at different spatial and temporal scale — include:

- Logical frameworks, focused on programme inputs, processes, outputs, outcomes and impacts;
- The DPSIR framework, which provides a convenient framework to analyse linkages among socioeconomic trends, ecological phenomena and institutional responses;
- The ICOM policy cycle framework, focusing on the implementation of the different steps of the programme or project cycle and the relevant progress markers; and
- Outcome-based frameworks, focusing on the intended and unintended on-the-ground environmental, socioeconomic, and institutional effects of programmes and projects.
- Ecosystem-based management framework, aiming at identifying the most important ecosystem properties and component and impacting human activities.

Differences among the conceptual frameworks — in terms of objectives, focus, methodology, conduct and use — are summarized in Box 6-1. It should be noted that no single framework may be sufficient to isolate results and elucidate the validity of the programme logic of an ICOM intervention. A combination of frameworks is therefore recommended depending on the needs and the information available.

The steps involved in Stage A include the identification of the goals and objectives of the ICOM programme or project, the selection and prioritization of a limited number of related indicators and the exploration of the possible interactions among them.

Step A.1 Identifying goals and objectives

Task a. Identify the goals and objectives of the programme

Identify the goals and objectives of the programme under evaluation. The process assumes that goals and objectives have at least been explicitly stated; in the best cases, these would have also been defined in quantitative terms as "targets" and/or in relation to temporal limits ("deadlines" or "timetables"). Goals and objectives would have been expressed in the project document or ICOM plan or programme.

Task b. List goals and objectives using Worksheet A-1

List the goals and objectives in Worksheet A-1 in relation to the key issues that they address. For some or most of the objectives the project or programme document may contain a series of performance indicators and means of verification.

Step A.2 Selecting indicators for each goal and objective

Task a. Select indicators associated with each goal and objective using Worksheet A-1

Record indicators associated with each goal and objective using Worksheet A-1; indicators might have already been defined (e.g., through a logical framework) or chosen from the menu provided in the handbook.

Step A.3 Prioritizing a subset of indicators

Task a. Identify those indicators that are relevant to more than one objective

Most likely, each objective will require the measurement of more than one indicator; likewise, some of the indicators will be relevant to more than one objective. From the proposed list, identify those indicators that measure progress towards a greater number of goals and objectives.

Task b. Assess the relevance of indicators and rate them based on the criteria listed in Worksheet A-2

After identifying the indicators, examine and rate them according to the five criteria listed in Worksheet A-2.

Task c. Prioritize a subset of indicators based on the above criteria

It should be possible to prioritize a small number of indicators based on their relevance to goals and objectives, data readiness, feasibility and other criteria. Indicators that require the collection of new data may be considered based on their importance and/or cost-effectiveness. Indicators could also be prioritized based on their interest to the highest number of user groups (see http://www.phys.ocean.dal.ca/~lukeman/COOP/ for a method and tool developed by the Coastal Ocean Observing Panel of the Global Ocean Observing System [GOOS/COOP]).

Step A.4 Identifying how the indicators relate to each other

Task a. Consider indicators in the context of a conceptual framework

The prioritized indicators should not be seen in isolation but rather within the context of a conceptual framework that allows their interrelationship to be explored. Examples of conceptual frameworks are provided (Examples A-1 to A-10). Some of the examples focus on a linear progression from inputs injected into the project to final outcomes and impacts; some focus on the iterative stages of an ICOM initiative; others highlight relationships between human activities and the state of the environment.

Task b. Identify the correlations among the indicators

By exploring different frameworks, it could be determined if the set of priority indicators selected makes sense as a whole. At this stage, it is impor-

tant to define the project logic and isolate expected correlations among the indicators, making use of the most appropriate frameworks.

As seen in chapter 2, the ICOM process can be analysed by the application of indicators in relation to inputs, processes, outputs and outcomes (IPOO, Example A-6) according to the different steps of the policy cycle and within the DPSIR framework (Example A-7 and A-8).

Worksheets A-3/I-IV provide a series of key questions and checklists for the application of governance indicators within the framework of the ICOM policy cycle.

STAGE B – PLANNING THE TEST

Having prioritized the indicators, it is necessary to estimate the human and financial resources and equipment required for the test. The identification of the target audience is also an important factor in determining how the test will be conducted and results reported. Depending on the primary purposes and the modalities of the test evaluation, stakeholders may be involved, not just as providers of information, but also in the monitoring phase itself. A monitoring and evaluation framework is then developed, with details of the indicators, data collection methods and frequencies, as well as responsibilities. The test may be planned as part of an ongoing monitoring and evaluation process, relying on key monitoring and evaluation structures, procedures and events, or as a separate exercise. In the best case, the test will contribute both an evaluation of past ICOM activities and a framework to enhance existing monitoring and evaluation processes.

Step B.1 Identifying sources of data for the indicators

Task a. Identify the sources of data for the indicators

Identify the sources or repositories of data for each of the indicators. Data may be stored internally in the agency charged with ICOM or in other agencies.

Task b. Assess the coverage and quality of data

For each dataset, assess the spatial and temporal coverage, as well as the quality of data.

Step B.2 Assessing human and financial resource needs

Task a. Determine the human resources needed for measuring and analysing the indicators

Assess the expertise required to measure or compile the indicators, the number of people to be involved (depending on the spatial and temporal extent of the test) and eventual training needs.

Task b. Determine the equipment needed for measuring and analysing the indicators

Determine the equipment needed to collect the required data (e.g., renting of boats or trucks, laboratory equipment, etc.).

Task c. Estimate the budget needed for applying the indicators

Based on the human and financial resources and equipment needed, prepare a budget for the conduct of the test. Worksheet B-1 provides a reference for main categories and specific items of cost.

Task d. Assess the budget needed against the resources available; decide whether additional resources are to be secured

At this stage, it will be possible to determine whether existing resources allow the test to be undertaken as expected. If resources are not sufficient, a reduced number of key indicators may be selected or other actions taken to secure additional funding. An incremental approach may be adopted by limiting the test to the indicators for which adequate resources are available, and planning the compilation and measurement of additional indicators in a second phase.

Step B.3 Determining the audience for the results from the test

Task a. Determine the audience for the results of the test

Identify the intended recipients of the results of the test in advance, in order to focus the test and create the best conditions for the practical application of the results. This may be the same government agency in charge of the ICOM initiative or a wider group of stakeholders that have participated in the compilation or measurement of the indicators. It is useful to explore all the potential audiences that may be interested in the results and the appropriate forms of communication that could be used to reach them.

Task b. Prioritize the audience for the results of the test

Select a primary target audience for the results of the test. In addition to the report due to IOC according to its specifications, the results of the test should be communicated to a primary audience in a form suitable to stimulate management actions. As indicated in Step A.3, the COOP method (http://www.phys.ocean.dal.ca/~lukeman/COOP/) may be suitable to determine the most relevant stakeholders for each issue.

Step B.4 Identifying who should participate in the test

Task a. Determine the level of expertise required to carrying out the test

Identify the level of expertise required to carry out the test. In principle, an interdisciplinary team composed of an ICM manager, a marine biologist/ecologist, an economist and a social scientist will be necessary. As an alternative, particularly where good-quality data are available, the compilation may be undertaken by a single test coordinator or, where data collection is necessary, by additional personnel.

Task b. Determine the in-house availability of resources for carrying out the test and, if needed, hire external consultants

Determine whether staff available in-house are adequate to carry out the test; consider the opportunity to contract some tasks out to an external consultant, depending on the availability of resources (see also Worksheet B-1).

Task c. Decide whether to involve stakeholders and establish the team to conduct the test

When possible, the conduct of the test should be participatory, involving all stakeholders and interest groups. Participation can occur at different levels: in the selection of the indicators, in the compilation or collection of data, as well as in the reporting phase. Once decisions are made concerning the internal and/or external expertise required and the involvement of stakeholders, a team should be established to conduct the indicator test, and roles and responsibilities assigned.

Step B.5 Developing a timeline and work plan for the test

Task a. Determine the time needed to conduct the test

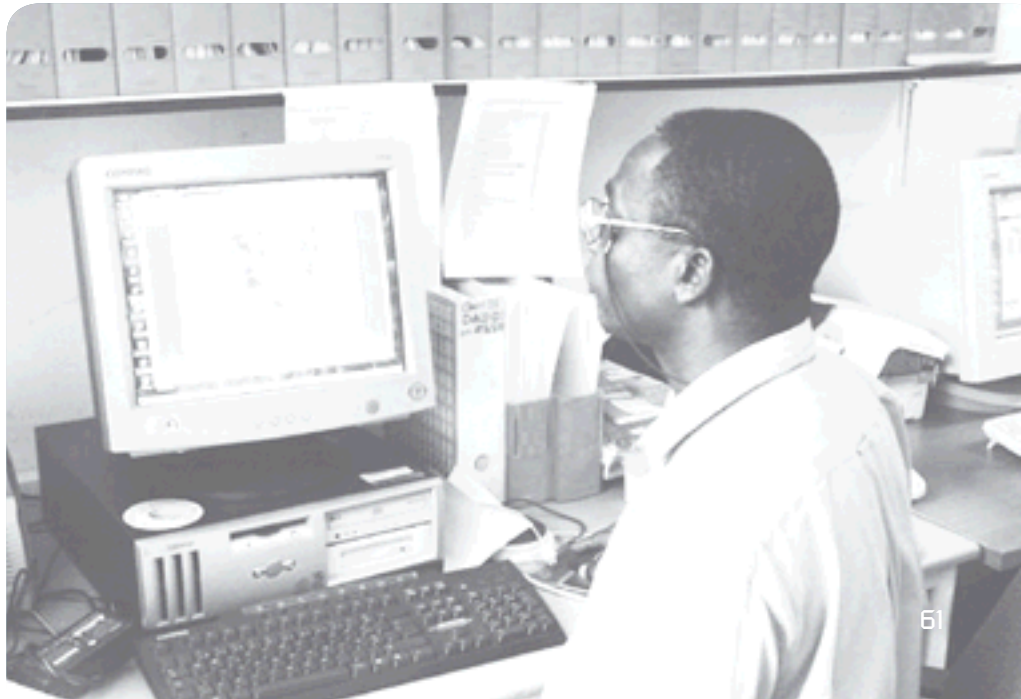
The conduct of the test will entail the implementation of a number of activities. For each activity, estimate the amount of time needed, identifying task dependencies (predecessors and successors) and milestones, and attempting to optimize task completion by clustering data compilation/collection for indicators with similar collection methods, sources, or seasonality. A Gantt chart may be used for this purpose (see Example B-1).

Task b. Determine when to conduct the test

While the test is expected to be carried out within a particular time period, you may want to consider — particularly with respect to the prospect of continuing or repeating the test through your regular monitoring and evaluation processes — to schedule the compilation or collection of data of specific indicators based on the seasonality of information generation (e.g., censuses, fishing seasons, tourist season, etc.).

Task c. Develop a work plan and timeline/monitoring and evaluation matrix

After determining activities and schedule, compile the information into a monitoring and evaluation matrix for the test, highlighting performance questions, indicators and status of baseline information, methods for data gathering, resources and responsibilities and use of the information (Ex-



ample B-2). Whenever possible, the development of the test should be associated with key monitoring and evaluation events (e.g., the preparation of progress reports).

STAGE C – CONDUCTING THE TEST

Stage C is concerned with the implementation of the indicator test. It implies the collection and the analysis of the data. Possible methodologies for data collection must be explored and a sample area identified if it is not possible to cover the entire management area. Responsibility for the collection and management of data should be assigned to a member of the team. A data storage system should be developed to facilitate the process as different typologies and forms of data will have to be put into a database. Once all the data are collected according to the goals of the test, their analysis should be performed using statistical methodologies. To give credibility and legitimacy to your work, a peer review by both internal and external reviewers should be encouraged before the results are communicated.

Step C.1 Implementing the work plan for the test

Task a. Start the implementation of the work plan for the test
Once the work plan and timeline are established, the test can be initiated following the sequence of tasks using a Gantt chart.

Step C.2 Collecting/compiling data

Task a. Explore data collection/compilation methods
The compilation and/or collection of data for the test will depend not only on data availability, but also on the quality of data collection methods and compilation. Different data collection methods are utilized for indicators, based on their focus, spatial scale and frequency of measurement (cf. Examples A-7 and C-1).

Task b. Reassess the availability of data
Reassess the data collection and compilation methods in relation to available data (see Step B-1), in order to match data and methods.

Task c. Select a sample, if necessary
When it is not possible to obtain data for all the area covered by an ICOM initiative, a representative sample can be selected (e.g., random or non-random sample).

Task d. Collect/compile data
Start the compilation and/or collection of data.

STAGE D – COMMUNICATING THE RESULTS

Stage D is concerned with the preparation and dissemination of the report with the results of the test. You can choose different typologies of communication according to the target audiences you have identified and according to the themes that are of major interest to them. In this stage, you can compare the results obtained with the original goals of your ICOM initiative and consider incorporating some of the findings into your future decisions regarding the progress of your programme.

Step D.1 Preparing a report on the results of the test

Task a. Writing the report
Prepare the report, which will include all the steps and tasks undertaken, following the points in Worksheet D-1.

Step D.2 Disseminating the report

Task a. Choose an appropriate format for communicating results to the audience
Choose different formats for communicating your results, according to the results of step B-3 and to the characteristics of the selected audience (Example D-1).

Task b. Create your strategy and timeline to communicate the results
Identify a timeline for delivering and communicating the results, according to the typology of the format selected for the communication of results. You can also develop your communication strategy according to the interests of stakeholders.

Task c. Identify priority issues for stakeholders and communicate the results to them

Select the kind of message you want to deliver to stakeholders, according to their interests. You can select specific indicators for specific groups of stakeholders (Worksheet D-2).

Step D.3 Considering the recommendation of the report for possible adjustment in the programme

Task a. Compare the results obtained with the original programme objectives

After obtaining the results, make a comparison with the original objectives of the ICOM programme. Having associated the selected indicators with the goals and objectives of the programme at the beginning of the test (See steps A.1-A.2), you can start a learning cycle to use the results of your test for possible adjustment in the programme.

Task b. Incorporate the results obtained into future decisions

Following the communication of the results to the target audience, a learning process could start. This testing phase could lead to the improvement of management and planning of your ICOM initiative. This is the concept of adaptive management (Example D-2) in which you start with asking questions, collect information to answer them, learn from the results and adapt behaviour and practices in a cyclical way. As these results should be incorporated in an ongoing planning and management process, you should evaluate the results obtained from the test with other sources of information, and with your past experiences. Try to adopt some flexibility in eventually finding new mechanisms to make changes. Determine the best way to make these changes and try to do it in a participatory manner, consulting with all stakeholders.

Table 6-2 The ICOM indicator test: Stages, steps and associated worksheets, checklists and examples from the test case studies

Stage	Step		Worksheets	Examples	Checklist
Introduction					
A. Selecting the indicators for the test	A.1	Identifying goals and objectives	Worksheet A-1		Checklist A
	A.2	Selecting indicators for each goal and objective	Worksheet A-1		
	A.3	Prioritizing a subset of indicators	Worksheet A-2	Examples A-1/A-2	
	A.4	Identifying how the indicators relate to each other	Worksheets A-3/I-IV	Examples A-3/A-10	
B. Planning the test	B.1	Identifying sources of data			Checklist B
	B.2	Assessing human and financial resource needs	Worksheet B-1		
	B.3	Determining the audience for the results from the test			
	B.4	Identifying participants for the test			
	B.5	Developing a timeline and work plan for the test		Examples B-1/B-2	
C. Conducting the test	C.1	Implementing the work plan for the test			Checklist C
	C.2	Collecting/compiling data		Example C-1	
	C.3	Managing the data		Example C-2	
	C.4	Analysing the data			
	C.5	Peer reviewing of results			
D. Communicating results from the test	D.1	Preparing a report on the results of the test	Worksheet D-1		Checklist D
	D.2	Disseminating the report	Worksheet D-2	Example D-1	
	D.3	Considering the recommendations of the report for possible adjustments to the programme		Example D-2	

Worksheets, examples and checklists

Worksheet A-1 **ICOM goals, objectives and indicators**

			Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6	Indicator 7	Indicator 8	Indicator 9	Indicator 10	…
Issues	Goals	Objectives											
Issue 1	Goal 1	Objective 1											
		Objective 2											
		Objective 3											
	Goal 2	Objective 4											
		Objective 5											
		Objective 6											
…	…	…											

Worksheet A-2 Criteria for rating ICOM indicators
Each indicator could be ranked in an ordinal way, e.g., on a scale from 0 to 3 (lowest to highest)

Criterion	Explanation	Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	…
Relevance to ICOM	Does the indicator measure, and is sensitive to, socioeconomic, governance, cultural and human health phenomena and trends that are directly or indirectly related to the state of the coast as measures of a healthy or unhealthy state, impacting pressures and behaviours, and policy responses to achieve sustainable coastal development?						
Data readiness and feasibility	Is the indicator based on readily available and routinely collected data, or data collectable at a reasonable cost-benefit ratio and in a timely manner, with sufficient spatial and time coverage and quality?						
Conceptual and methodological soundness	Is the indicator conceptually and methodologically well-founded, representative of established approaches and standards by the scientific community, international and regional organizations and national and local practices?						
Management responsiveness	Is the indicator responsive to management interventions related to key policy goals and objectives for the coastal area, and could it be measured in relation to progress towards agreed targets and timetables?						
Transparency and understandability	Can the indicator be readily communicated to policy-makers, eventually as an early warning signal, and understood by the stakeholders and the public in a non-scientific form and express an unambiguous message about the progress of ICOM and the state of the coast?						
	Total						

Worksheet A-3/I Governance indicators applied in Phase I of the ICOM policy cycle

STEP		Phase I: Preliminary identification		
		Key questions	**Checklist**	**Indicators**
	0. Initialization conditions	☐ Is there any lead agency or informal group or coalition promoting an ICOM process?	✔ An "ICOM pioneering group" is promoting the establishment of an ICOM process	G1
	1. Feasibility of implementation	☐ Have issues at stake and relevant stakeholders been identified and scoped?	✔ An analysis and scoping of issues at stake and relevant stakeholders have been carried out	G9
		☐ Does a formal or informal forum exist where stakeholders are represented to address ICOM issues?	✔ An ICOM task force inclusive of key coastal stakeholders has been created	G1
		☐ Are the functions and tasks of administrative actors involved in ICOM sufficiently defined?	✔ The ICOM-related roles of public administrations are clearly defined by legislation or administrative acts	G1
		☐ Does legislation enable the implementation of ICOM goals, objectives and activities?	✔ National, regional or local legislation and regulations allow regulation of the use of coastal spaces and resources according to ICOM principles	G2
		☐ Are conflicts over coastal spaces and resources being satisfactorily resolved?	✔ Procedures for conflict resolution, formal or informal, have been agreed	G8
		☐ Are staff trained and experienced in ICOM principles and activities?	✔ Staff dedicated to the ICOM process have adequate experience and background	G12
		☐ Are available technical and financial resources adequate to start an ICOM process?	✔ Adequate facilities, equipment and financial resources have been identified to start an ICOM process	G8

Worksheet A-3/II Governance indicators applied in Phase II of the ICOM policy cycle

STEP		Phase II: Preparation		
		Key questions	**Checklist**	**Indicators**
	2. Socio-environmental assessment	☐ Are the potential environmental impacts of coastal- and marine-related sectoral plans, programmes and projects regularly assessed?	✔ Plans, programmes and projects potentially impacting on the coastal and marine environment are regularly subject to strategic environmental assessment and environmental impact assessment procedures	G3
	3. Desirable and possible scenarios	☐ Is sufficient scientific information available to enable an ICOM process (e.g., for environment-development scenarios)?	✔ ICOM micro-projects have been carried out as practical exercise to mobilize staff, generate information and test management approaches ✔ Sufficient results from scientific research and micro-projects are available to enable an ICOM process	G9
		☐ Are stakeholders being involved in the decision-making process considering options for a management plan?	✔ The ICOM decision-making level is open to, and inclusive of, all stakeholders	G10, G11
		☐ Have different options for the coastal area in environmental and developmental terms been considered?	✔ Environment-development scenarios for the coastal area have been formulated and analysed	G9 (to be expanded)
		☐ Can adequate human, technical and financial resources be mobilized for an ICOM process?	✔ Sectoral and dedicated resources can be mobilized for supporting the ICOM process	G8, G12
	4. Elaboration of a management plan	☐ Is there a shared long-term vision for the coastal area?	✔ Based on desirable and possible scenarios, key stakeholders have agreed on a long-term vision for the coastal area	G7, G12
		☐ Has a management plan been formulated addressing all the key issues in the coastal area?	✔ The scope, goals, objectives and strategies of a management plan (including zoning) have been defined	G5
		☐ Is there adequate support to the management process from coastal stakeholders?	✔ The management plan has been acknowledged and validated by coastal stakeholders	G8 (to be expanded)

Worksheet A-3/III Governance indicators applied in Phase III of the ICOM policy cycle

		Phase III: Implementation		
		Key questions	**Checklist**	**Indicators**
STEP	5. Institutionalization	☐ Are institutional arrangements for ICOM becoming operational?	✔ An ICOM coordinating body or mechanism has been formalized	G1
		☐ Is the ICOM process supported by adequate legal and administrative arrangements?	✔ Guidance documents, regulations (e.g., zoning) and partnership agreements for implementing the ICOM process have been formalized	G2
		☐ Are coastal conflicts been addressed in an adequate forum and in a satisfactory way?	✔ A functional mechanism is in place for the resolution of coastal conflicts, which appear satisfactorily resolved	G4
		☐ Are human, technical and financial resources being allocated on a sustainable basis?	✔ Adequate formed/trained and performing staff, sustained financial resources, regularly maintained facilities and equipment have been allocated to manage, support and carry out ICOM activities and interventions	G8
	6. Implementation of the management scheme	☐ Are adequate education and training activities supporting the ICOM process?	✔ University and agencies programmes and training courses are officially incorporating ICOM in their curricula	G12
		☐ Is the management plan being effectively and efficiently implemented?	✔ Records of the ICOM process / project show tangible progress at all levels, including governance performance and on-the-ground results in both ecological and socioeconomic terms	G5, G6, G13, G14, G15
		☐ Are human, technical and financial resources being spent	✔ Human, financial and technical resources for ICAM are been spent	G8
		☐ Are key stakeholders, including NGOs and local communities supporting the ICOM process?	✔ There is evidence of positive changes in behaviour of coastal stakeholders	G10, G11

Worksheet A-3/IV **Governance indicators applied in Phase IV of the ICOM policy cycle**

		Phase IV: Consolidation, replication and expansion		
		Key questions	**Checklist**	**Indicators**
STEP	8. Consolidation	☐ Has the effectiveness of the ICOM approach been sufficiently demonstrated?	✔ There are tangible result to demonstrate that ICOM has been a successful approach to address coastal environmental problems and promote sustainable coastal economies	G7
		☐ Has the ICOM process contributed to the formulation of good practices and guidelines that are applicable elsewhere in the coastal area or at a higher scale?	✔ There is institutional and political recognition that ICOM is working and its role is understood by practitioners and the general public ✔ The experience from the ICOM process has been distilled into good practices and guidance documents	G7, G9 (both to be expanded)
	9. Replication	☐ Is the ICOM process being sustained over a longer-term?	✔ Regular resources for the ICOM process remain constant or increase ✔ New resources are leveraged to implement and sustain the ICOM process	G8
		☐ Have experiences in ICOM been exchanged with coastal managers from other parts of the coastal area?	✔ [Long-term] capacity building efforts have been activated to exchange and share experiences and skill development	G9 (to be expanded)
		☐ Has the ICOM approach been adapted and applied to other parts of the coastal area through similar ICOM initiatives?	✔ Other ICOM projects have been initiated in other parts of the coastal area	G5, G6
	10. Expansion	☐ Is the integrated approach being adopted in other sectors influencing the coastal area?	✔ Integrated approaches consistent with ICOM have been activated for the management of watersheds and coastal seas	(see indicators not yet developed)
		☐ Has the percentage of national coastline covered by active ICOM plans increased?	✔ There is a steady increase of the percentage of the national coastline covered by formally adopted management plans ✔ Adopted management plans are being actively implemented (e.g., through investments in infrastructure)	G4, G5
		☐ Has the ICOM process been integrated into a national sustainable development strategy?	✔ ICOM goals and objectives are incorporated into a regional or national sustainable development strategy ✔ ICOM-related activities within the sustainable development strategy are supported by adequate means	G15
		☐ Has the ICOM approach been utilized to solve problems of international scope?	✔ ICOM decisions are influenced by international agreements, recommendations and guidelines ✔ There is active participation in international ICOM efforts	(see indicators not yet developed)

Example A-1 Assessing the performance of integrated coastal management programmes in Xiamen, China and Batangas Bay, Philippines, 1994 – 1998 (from Xiamen ICM project report)

1 Problem identification and programme formulation	**Xiamen, China**	**Batangas Bay, Philippines**
Environmental profile prepared (1); problems identified and prioritized (1); management boundary defined (1)	3	3
Programme planning undertaken (1), stakeholders consulted (1)	2	2
Primary data related to programme formulation gathered (1)	1	1
Public awareness created (1)	1	1
EIA/risk assessment performed (1)	1	1
Strategic management plan formulated (1) and adopted (1)	2	2
Issue of special area plan developed (1) and adopted (1)	2	2
Organizational (1) and legal (1) arrangements proposed	2	2
Financial options developed (1)	1	1
Environmental monitoring protocol developed (1)	1	1
Information management system established (1)	0	0
2 Programme implementation		
Interagency, intersectoral council /committee/group established (1)	1	1
Coordinating agency /office for programme implementation established (1)	1	1
Capacity (1) and information generating arrangement established (1)	2	2
Prioritized agenda for management action undertaken (1)	1	1
Financial mechanism for programme implementation established (1)	1	1
Environmental monitoring mechanism established (1) and operational (1)	2	2
Concerned ordinance/ legislation developed (1) and approved (1)	2	2
Law enforcement mechanism established (1)	1	1
Programme monitoring and evaluation protocols developed (1) and implemented (1)	2	2
3 Programme Sustainability		
Perception and attitude changes among stakeholders detected (1)	1	1
Critical mass of local /national officials knowledgeable about ICM formed (1)	1	1
Major stakeholders participated in programme implementation (1)	1	1
Human and financial resources by government and stakeholders for Continuation of programme committed (1)	1	1
Continue implementation of prioritized agenda of the action plan committed by local government(1)	1	1
Integration of ICM programme into local government environmental management and sustainable development framework undertaken (1)	1	1

Example A-1 (continued)

4. Programme's impacts	Xiamen, China	Batangas Bay, Philippines
Environmental quality shows sign of improvement (1)	1	0
Some environmental degradation arrested (1)	1	0
Interagency conflicts reduced or resolved (1)	1	1
Use conflicts minimized or resolved (1)	1	1
Evidence of ecological improvement (1)	1	1
Evidence of socioeconomic benefits (1)	1	0
Additional financial support from national government/ external sources (1)	1	1
Total Score	**42**	**39**

Example A-2 Rating of ICOM indicators according to Xiamen ICM project report
Governance, ecological and socioeconomic indicators are ranked in an ordinal way on a scale from 0 to 3 (lowest to highest)

Indicator	Relevance to ICOM	Data readiness and feasibility	Conceptual and methodological soundness	Management responsiveness	Transparency and understandability	Total
G1	3	3	3	2	2	13
G2	3	3	3	2	2	13
G4	3	2	3	2	2	12
G7	3	3	3	2	2	13
G8	3	1	3	2	1	10
G9	2	2	3	1	1	9
G10	3	2	3	1	1	10
G11	3	2	3	1	1	10
G12	3	2	1	1	1	8
G15	3	3	3	2	2	13
S1	3	2	2	1	1	9
S3	3	2	2	1	1	9
S4	3	2	2	2	2	11
S5	3	2	2	1	1	9
S8	2	2	2	1	1	8
S9	2	1	2	1	1	7
S10	2	1	2	1	1	7
E1	3	2	3	2	2	12
E7	3	2	2	2	2	11
E8	3	2	3	2	2	12
E9	3	2	3	2	2	12
Total	**59**	**43**	**53**	**42**	**31**	**218**

Example A-3 Contextual and performance measures (based on NOAA, 2004)

Issue	Contextual measures			Performance measures				
	Drivers	Pressure	State	Inputs	Process	Output	Outcome	Impact
Coastal habitats		Land use change Population growth	Extent and status of priority habitats	Funds spent to protect priority habitats	Approved habitat restoration plans	Permit issued that disturb coastal habitats	Changes in the extent and status of coastal habitats due to protection or restoration	
Water quality		Changes in impervious surfaces Land use change Population growth	Percent water bodies impaired, including from non-point pollution sources	Funds spent to manage coastal development to improve, safeguard, and restore water quality	Approved coastal non-pollution control plans and related measures	Capacity building activities in coastal watersheds	Percent coastal watershed enhanced Changes in restriction to shellfish beds	
Coastal hazards	No. hazards per year Value of damage from coastal hazards Coastal disaster declarations Financial assistance for disaster remediation	People in hazardous areas Land and properties in hazardous areas	Hazardous areas	Funds spent to manage coastal development to minimize loss of life and properties from coastal hazards	Approved setbacks and buffers	Activities to reduce future damage from coastal hazards Educational and awareness- raising campaigns	Areas protected by setbacks, buffers and public ownership	

Example A-4 Progress across stages of ICM
(based on ETC/TE, 2004 and Pickaver et al., 2004, Guidance notes updated in 2006)

Phase	Planning and management are taking place in the coastal zone	A framework exists for taking ICZM forward	Most aspects of an ICZM approach to planning and managing the coast are in place and functioning reasonably well	An efficient, adaptive and Integrative process is embedded at all levels of governance and is delivering greater sustainable use of the coast
Action	1. Decisions about planning and managing the coast are governed by general legal instruments. 2. Sectoral stakeholders meet on an ad hoc basis to discuss specific coastal and marine issues. 3. There are spatial development plans which include the coastal zone but do not treat it as a distinct and separate entity. 4. Aspects of the coastal zone, including marine areas, are regularly monitored. 5. Planning on the coast includes the statutory protection of natural areas.	6. Existing instruments are being adapted and combined to deal with coastal planning and management issues. 7. Adequate funding is usually available for undertaking actions on the coast. 8. A stocktaking of the coast (identifying who does what, where and how) has been carried out. 9. There is a formal mechanism whereby stakeholders meet regularly to discuss a range of coastal and marine issues. 10. Ad hoc actions on the coast are being carried out that include recognizable elements of ICZM. 11. A sustainable development strategy that includes specific references to coasts and seas is in place. 12. Guidelines have been produced by national, regional or local governments that advise planning authorities on appropriate uses of the coastal zone.	13. All relevant parties concerned in the ICZM decision-making process have been identified and are involved. 14. A report on the State of the Coast has been written with the intention of repeating the exercise every five or ten years. 15. There is a statutory integrated coastal zone management plan. 16. Strategic Environmental Assessments are used commonly to examine policies, strategies and plans for the coastal zone. 17. A non-statutory coastal zone management strategy has been drawn up and an action plan is being implemented. 18. There are open channels of communication between those responsible for the coast at all levels of government. 19. Each administrative level has at least one member of staff whose sole responsibility is ICZM. 20. Statutory development plans span the interface between land and sea. 21. Spatial planning of sea areas is required by law. 22. A number of properly staffed and properly funded partnerships of coastal and marine stakeholders have been set up. 23. Coastal and estuary partnerships are consulted routinely about proposals to do with the coastal zone. 24. Adequate mechanisms are in place to allow coastal communities to take a participative role in ICZM decisions.	25. There is strong, constant and effective political support for the ICZM process. 26. There is routine (rather than occasional) cooperation across coastal and marine boundaries. 27. A comprehensive set of coastal and marine indicators is being used to assess progress towards a more sustainable situation. 28. A long-term financial commitment is in place for the implementation of ICZM. 29. End users have access to as much information of sufficient quality as they need to make timely, coherent and well-crafted decisions. 30. Mechanisms for reviewing and evaluating progress in implementing ICZM are embedded in governance. 31. Monitoring shows a demonstrable trend towards a more sustainable use of coastal and marine resources.

According to the new ICZM guidance notes (Measuring Progress in the Implementation of Integrated Coastal Zone Management - Guidance notes for completing the Progress Indicator - EU Working Group on Indicators and Data, 2006)

Example A-5 Logical framework (based on AIDEnvironment/RIKZ, 2004): example from Thailand Charm project Monitoring Board

Intervention Logic	Objectively Verifiable Indicators	Sources of Verification	Assumptions
Overall Objective: Sustainable use of coastal habitats and resources through institutional strengthening at different governance levels.	By end of project: 1. There is evidence of improved conditions in coastal resources management and livelihoods in at least 24 coastal units defined by the project vulnerability mapping and planning tool. 2. Sustainable fisheries and natural resources management practices adopted in at least 20 Tambon. 3. Coastal units where the 20 Tambon are located have their vulnerability index improved by 10%.	4. Routine M and E reports from participating communities. 5. Quantification of stock recovery through published reports. 6. Improved catch rates, yields and resource distribution (DoF and other supporting institution extension officer reports). 7. MCS illegal fishing reports within pilot Tambon. 8. Reduction in the level of poverty and enhanced food security as verified through CDD. 9. Local governments reports and plans.	
Project Purpose: The coastal co-management framework and procedures in two Southern Thailand locations are designed and established to be replicated elsewhere in the country.	By end of project: 10. At least 70% of project results against plan achieved. 11. A least 20 TAOs from the two project areas have incorporated a coastal habitats and resources co-management strategy and activities into their mid-year and annual plans. 12. Co-management planning on specific issues has been scaled up between several Tambon at District level. 13. Developed co-management models are considered and used for replication elsewhere in the country.	14. End of Year 4 survey. 15. End of project survey. 16. CHARM progress and final reports. 17. TAO mid-term and annual plans. 18. Representation structure at Tambon level. 19. Occupational groups reports. 20. Groups' micro-credit lending accounts. 21. CHARM information base. 22. Inter-provincial, Tambon and intercommunity workshop outputs and reports. 23. Extension officers back to office reports.	• Governmental political will in coordinating sectoral policies. • Enough motivation of coastal communities in participation in CRM. • Mechanism for interdepartmental cooperation and framework in post project period maintained. • Implementation of decentralization related-laws. • Local Government Agencies are given the financial capacity.
Component 2 - Participatory management			
Result 1: Community and local authorities are involved in coastal habitats and resources co-management.	By end of project: 24. Operating village/ TAO consultative mechanism in at least 20 Tambon with at least 4 villages in each Tambon. 25. Incorporation of CRM into at least 20 TAO annual action plans. 26. 20 MCS groups functioned. 27. 5 Tambon outside project areas (incl. Ranong) successfully participated in village/TAO co-management consultative processes.	28. Project information sheets indicating projects adopted per household/village. 29. RTG/CHARM support expenditure. 30. TAO annual reports. 31. Reports of extension visits made, workshops, and advice given. 32. Project information sheets. 33. AWP4 progress reports.	34. Local inhabitants can see benefits within reach if they participate. 35. Disadvantaged groups have access to and are willing to beneficiate from activities. 36. Activities move from project mentality to natural resources management mentality.

Example A-6 Governance indicators by phase and step of the ICOM policy cycle and according to the Input-Process-Output-Outcome framework

Phase	Step	Performance measures			
		Input	Process	Output	Outcome
1. Preliminary identification	0. Initialization conditions		G1 Coordinating mechanism (pioneer group) G10 Stakeholder participation (identification of players) G11 NGO and community involvement (identification of players)		
2. Preparation	1. Feasibility of implementation	G8 Availability of human, financial and technical resources G9 Availability of scientific information G12 Educational and training curricula	G1 Coordinating mechanism (task force) G1 Administrative functions defined G2 Legislation enabling ICOM		G4 Prioritization of problems
	2. Socio-environmental assessment	G9 Scientific research and information	G3 EIA, SEA and CCA procedures	G3 EIA, SEA and CCA procedures (assessments)	G10 Awareness and mobilization of players
	3. Desirable and possible scenarios	G9 Scientific research and information	G4 Conflict resolution mechanism	G3 EIA, SEA and CCA (scenarios)	G5 Shared vision, prioritization of goals and objectives, and course of action
3. Implementation	4. Elaboration of the management plan		G1 Coordinating mechanism (steering committee)	G5 Management plan (formulation; maps)	G5 Management plan (validation)
	5. Institutionalization	G8 Allocation of human, financial and technical resources	G1 Coordinating mechanism (formalized)	G5 Management plan (agreements) G10 Partnerships (agreements)	G5 Management plan (formal adoption) G15 Management plan incorporated into higher-level strategies and plans (institutional recognition)
	6. Application of the management scheme	G8 Allocation of human, financial and technical resources	G5 Management plan (agreements, guidelines and regulations) G13 Use of technology G14 Use of economic instruments		G1 Coordination mechanism (practice in inter-institutional coordination and leadership) G6 Coastline covered by active management plans (tangible accomplishments)
	7. Evaluation and adjustment	G9 Scientific research and information	G1 Coordinating mechanism G7 Routine monitoring, evaluation and adjustment		G6 Coastline covered by active management plans (practice in adaptive management)

Phases and steps of the ICOM policy cycle according to: Henocque, Y. and Denis, J. (editors), A Methodological Guide: Steps and Tools towards Integrated Coastal Area Management. IOC Manuals and Guides 42. UNESCO, Paris, 2001.

Example A-7 ICOM indicators within the DPSIR framework

Code	Indicator	Measurement	Type/Focus					Collection techniques
			D	P	S	I	R	
G1	Coordinating mechanism	- Existence and functioning of a coordinating mechanism for ICOM - Outcomes of the coordination process						- Document review (e.g., meeting records) - Interviews with ICOM managers and members
G2	Legislation	- Existence of legislation on coastal and marine resources - Adequacy of the ICOM legislation						- Document review - Interviews with ICOM managers and other experts - Surveys
G3	Environmental assessment	- Use of EIA and SEA procedures and modifications to coastal projects - Use of CCA procedures in coastal tourism development						- Document review (e.g., EIS) - Interviews with competent authorities - Databases
G4	Conflict resolution mechanism	- Agreed procedures and mechanisms for conflict resolution - Changes in the proportion of conflicts successfully mitigated, resolved, or prevented - Overall change in the number of conflicts						- Document and record review - Interviews - Surveys
G5	Integrated management plans	- Existence, characteristics, and status of ICOM plans - Extent (percentage) of coastline covered by ICOM plans						- Document review - Interviews
G6	Active management	- Level of implementation of ICOM plans, actions and projects, including infrastructure building - Procedures, legal tools, and monitoring and sanctioning applied for enforcement of ICOM plans/actions - Level of enforcement of, or compliance with, ICOM plans						- Document review - Interviews - Surveys
G7	Monitoring and evaluation	- Existence of an operational monitoring and evaluation system with related indicators - Consideration of results in ICOM initiatives - Adjustments made to ICOM initiatives						- Document and record review
G8	Human, technical, and financial resources	- Staff - Budget - Facilities						- Document and record review - Interviews
G9	Inputs from scientific research	- Existence of research studies and scientific publications - Completion of a diagnostic assessment that identifies root causes of coastal degradation and establishes priority for interventions - Existence and dissemination of a state of the coast report - Media events related to coastal issues - Existence and functioning of a science advisory body - Existence and operation of routine monitoring of the marine environment - Inputs from scientific research and diagnostic assessment into ICOM						- Document review - Interviews

Code	Indicator	Measurement	Type/Focus					Collection techniques
			D	P	S	I	R	
G10	Stakeholder participation	- Level of stakeholder participation - Level of stakeholder satisfaction with participation and with ICOM outcomes			■			- Interviews - Surveys - Document reviews
G11	NGO and CBO activity	- Existence and characteristics of NGOs and community organizations active in ICOM - Level of activity of NGOs and community organizations active in ICOM			■			- Document review - Interviews
G12	Education and training	- Educational and training programmes incorporating ICOM - People having completed educational and training programmes in ICOM - Employment of people with education and training in ICOM					■	- Document review - Surveys
G13	Technology	- Availability of ICOM-enabling and supporting technology at an acceptable cost - Level of use of ICOM-enabling and supporting technology in substitution of counter-ICZM technology - Level of coordination of ICZM-enabling and supporting technology					■	- Document review - Databases - Interviews - Surveys
G14	Economic instruments	- Availability of economic instruments, including environmental quality certifications, in conjunction with regulatory instruments - Level of implementation and enforcement of economic instruments					■	- Document review - Databases - Interviews - Surveys
G15	Incorporation of ICOM into sustainable development strategy	- Existence of sustainable development strategy or Agenda 21 incorporating ICOM chapter - Level of implementation of ICOM chapter of sustainable development strategy or Agenda 21					■	- Document review - Interviews - Surveys
E1	Diversity	- Diversity of communities - Diversity of populations - Diversity of species - Genetic diversity - Invasive species/pests			■	■		- Species inventories - Sampling - Monitoring programmes
E2	Distribution	- Horizontal distribution (patchiness, aggregation) - Vertical distribution (food web/trophic structure)			■	■		- Species inventories - Sampling - Monitoring programmes
E3	Abundance	- Biomass (key populations) - Number of individuals (marine mammals) - Density (plants, benthic organisms)			■	■		- Monitoring programmes and surveys
E4	Production and reproduction	- Complexity of food web - Key predator/prey interactions - Keystone species - Size spectra			■	■		- Remote sensing - Monitoring programmes and surveys
E5	Trophic interactions	- Complexity of food web - Key predator/prey interactions - Keystone species - Size spectra			■	■		- Monitoring programmes

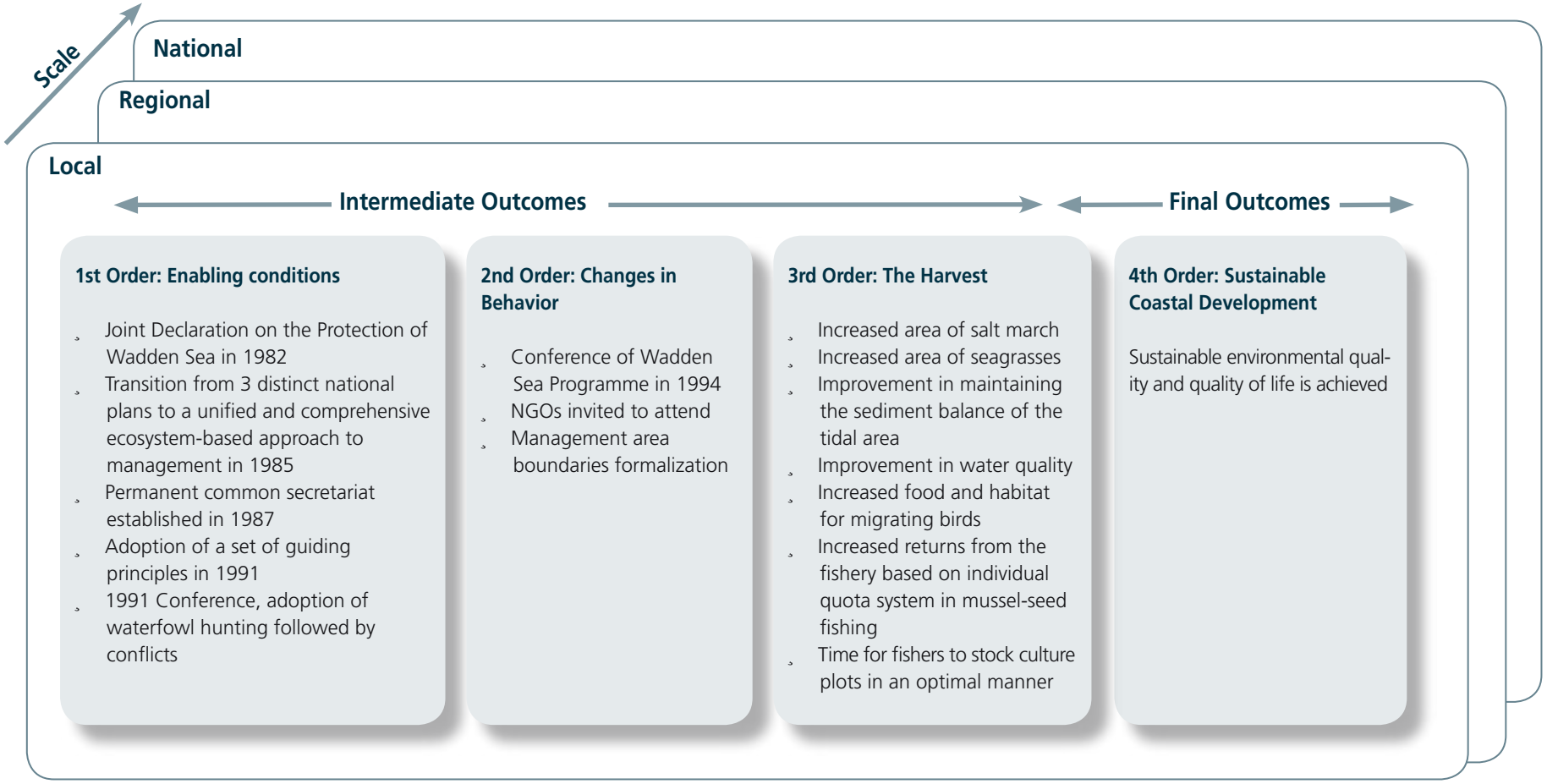
Code	Indicator	Measurement	Type/Focus					Collection techniques
			D	P	S	I	R	
E6	Mortality	- Fishing mortality - Incidental mortalities (by-catch) - Natural mortality (predation)						- Monitoring programmes
E7	Species health	- Species at-risk of extinction - (Bio)accumulation of toxic compounds - Diseases and abnormalities - Seafood quality						- Sampling
E8	Water quality	- Water column properties - Oceanographic processes and variability (and regime shifts) - Sedimentation (e.g., transport of suspended sediments) - Pollutants and contaminants - Eutrophication parameters						- Monitoring programmes
E9	Habitat quality	- Habitat types - Habitat alteration - Sea level change - Landscape and bottomscape integrity - Sediment quality (nature/properties of sediments)						- Field observation
SE 1	Total economic value	- Exploitation of living resources (commercial fisheries; artisanal fisheries; recreational fisheries) - Exploitation of non-living resources (oil and gas; minerals and metals) - Non-consumptive uses (shipping; tourism and eco-tourism) - Economic value-added - Value of exports - Management and administration costs						- Document review - Databases - Interviews - Surveys
SE 3	Total employment	- Number employed - Employment payroll value - Same sub-categories as total economic value						- Document review - Databases - Interviews - Surveys
SE 6	Pollutants and introduction	- Population served by wastewater treatment - Volume, number, and type of point-source discharges - Non-point-source nutrient loading (e.g., fertilizer use) - Discharged sediments and nutrients - Volume of ballast and bilge discharge - Litter and debris						- Monitoring programmes - Document review - Databases - Interviews - Surveys
SE 13	Protection of coastal heritage resources	- No. and type of cultural heritage resources - Percentage cultural heritage resources protected - Percentage cultural heritage resources vulnerable or damaged - Use of cultural heritage resources						- Cultural heritage registers - Aerial surveys - Fieldwork

Code	Indicator	Measurement	Type/Focus	Collection techniques
SE 5	Human pressure on habitats	- Land use/land cover patterns and composition - Population density - Extent of hard-surface areas - High-impact fishing gear/practices - Dumped and dredged material (e.g., shipping channel maintenance)		- Monitoring programmes - Document review - Databases - Interviews
SE 7	Disease and illness	- Fecal coliform counts - Days of beach closure - Extent of contaminated species - Extent of contaminated water - Seafood-vectored illnesses		- Monitoring programmes - Document review - Databases - Interviews
SE 8	Weather and disasters	- Economic value of loss from marine weather-related events - Lives lost from weather and marine disasters		- Document review - Interviews
SE 9	Population dynamics	- Degree of public access - Resident and total (seasonal) population - Marine attachment		- Document review - Databases - Surveys
SE 12	Traditional knowledge, innovations and practices	- Status and trends in linguistic diversity and speakers of indigenous languages - Recognition/existence/continuation of traditional land and water tenure of indigenous and local communities - Lands and waters managed or co-managed by indigenous and local communities - Movement(s) of indigenous and local communities away from traditional territories and inflows of new communities - Trends in the establishment and effective implementation of favourable government policies and programmes to preserve traditional knowledge, innovation and practices - Access to traditional coastal and marine resource rights - Trends in the manifestations of traditional knowledge		- Statistics and censuses - Public programmes and policies - Local community self-assessments
SE 13	Protection of coastal heritage resources	- No. and type of cultural heritage resources - Percentage cultural heritage resources protected - Percentage cultural heritage resources vulnerable or damaged - Use of cultural heritage resources		- Cultural heritage registers - Aerial surveys - Fieldwork

Example A-8 The DPSIR framework applied to the marine environment (IOC Indicator handbook after EEA, 2000)
(process of indicators selection from IKZM Oder project report)

IOC-Indicators	DPSIR-character	Usefulness for WFD (-- o ++)	Meaning of IOC indicator for the WFD	Existence of information /data (-- o ++)	Availability of data and information as well as important documents and publications
Governance indicators					
G1: Existence and functioning of a coordinating mechanism	R	++	The ICPOAP and related ministries are the statutory framework for a coordinating mechanism.	++	German spatial planning act (1998); WFD (2000/60/EC); Agreement of the ICPOAP (1996); LEP M-V (2005)
G2: Existence and adequacy of legislation	R	++	WFD and the German water act form the legal basis. They follow principles of sustainability, information and participation.	++	German spatial planning act (1998); Water act of Mecklenburg-Vorpommern (1992) ; WFD (2000/60/EC); Agreement of the ICPOAP (1996); LEP M-V (2005)
G3: Environmental assessment	R	+	WFD asks for EIA, SEA as well as CCA. It is too early for an evaluation.	++	Acts for EIA and SEA existing, equivalent for CCA; LEP M-V (2005); ESPOO-Convention (1991); regional concepts
G4: Existing and functionality of conflict resolution mechanism	R	+	Participation of stakeholders will minimize conflicts before preparation of a management plan	+	Spatial planning includes conflict resolution mechanisms; a lot of information available, but little information about efficiency
G5: Existence, status and coverage of ICOM plans	R	+	A management plan is under preparation and will include coastal waters up to a distance of 1 nm	+	Plan under preparation; the LEP M-V (2005),) and the WFD (2000/60/EC) as well as the report by the ICPOAP to the European Commission (2005) form a good basis
G5: Existence, status and coverage of watershed plans	R	++	A management plan is under preparation, coverage and contents are given by the WFD	+	Suitable WFD (2000/60/EC) plan is under preparation which fulfills ICOM demands
G5: Existence, status and coverage of management plans for coastal and marine ecosystems	R	+	A management plan is under construction, coverage and contents are given by the WFD	+	WFD plan under preparation and partly suitable; parallel activities concerning protection of ecosystems are Natura 2000, Marine Strategy and Marine Protected Areas

Example A-9 Orders of outcomes of ICM initiatives (based on Olsen & Nickerson, 2003) applied on Wadden Sea Trilateral Cooperation.



Example A-10 ICM programme performance indicators (based on Chua et al., 2003)

Status indicators	Environmental stress or pressure indicators	Process indicators	Response indicators	Sustainability indicators	Impact indicators
– Size and physical characteristics of the coastal area – Population size, distribution, education, and density – Percentage of population with water supply, sanitation services, electricity – Poverty indices (if applicable) – Ecosystems health: risk quotients of major ecosystems/ habitats – Level of urbanization/ classification – Land use patterns: percentage of land used for agriculture, aquaculture, forest covers, human settlement, industries, etc. – Percentage contribution of key economic activities to economic growth – Biodiversity: coastal and marine species inventory – Level of exploitation of natural resources – Types and levels of major pollutants – State of water quality for public health and for fish farming – National resource and environmental governance: institutional arrangement, legislations, legal and interagency conflicts; – Inventory of institutions or skills available at local level for integrated planning and management – Existing mechanism(s) for resolving multiple use conflicts – Types and level of environmental investment	– Rates of increase by types and level of pollutants – Rates of water quality deterioration, habitat degradation; and resource exploitation – Nature, level and rate of conversion of coastal habitats to other users – Expansion of pollution hotspots – Level of environmental risk quotients for water quality and ecosystems	– Site profiling undertaken – Problems identified and prioritized – Management boundary defined – Planning undertaken – Stakeholders consulted – Data/information analysed – Public awareness created – Communication plan developed – Environmental risk assessment performed – Strategic management plan formulated – Issue/area-specific plan developed – Organizational arrangement proposed – Legal arrangement proposed – Financial arrangement for programme implementation identified – Environmental monitoring programme developed – Information management system established and operational – Core group of officials and stakeholders trained – Programme monitoring, evaluation and reporting protocols developed	– Local level interagency, multisectoral coordinating mechanism operational – Coastal strategy/ strategic environmental management plan implemented – Site specific/ issue specific action plans implemented – Sea-use zoning scheme operational – Civil society group mobilized in planning and management – Communication plans implemented to inform stakeholders and public – Integrated environmental monitoring programme implemented – Required legislation and administrative orders adopted and implemented – ICM programme monitoring, evaluation and reporting protocols implemented – Integrated information management system operational – Stress reduction targets set and measures undertaken	– Sustainability Indicators – Perception and behaviour changes among stakeholders occur – ICM mainstreamed into local/national training and education system – Sustainable financing systems in support of ICM programme operationalized – Mainstreaming of ICM into national or sub-national policy – Integration of ICM programme into local government development programme – Mechanisms for knowledge generation, sharing and extension established and operational	Environmental impact – Visual sign of improvement of environmental quality (water, sediment, biota, air quality) – Percentage of nutrient reduction – Percentage of degraded habitats restored – Area or length of coastline rehabilitated through shoreline management – Areas of ecosystems protected/ preserved – Reduction of risks to ecosystem and public health Economic impact – Increase in average household income – Increase in employment opportunities – Poverty reduced – Pollution damage cost reduced – Investment in environmental improvement increased – Investment in cleaner production technology increased Social impact – Reduced incidence of multiple-use conflicts – Reduced risks to public health associated with environment degradation such as waterborne diseases – Reduced seafood poisoning due to toxins/contaminants – A well-informed public – High environmental awareness – Increased transparency in governance

Checklist A Selecting the indicators

Step	Task	Completed
A.1	a. Identify the goals and objectives of the programme based on documents	☐
	b. List goals and objectives using Worksheet A-1	☐
A.2	a. Selecting indicators associated with each goal and objectives using Worksheet A-1	☐
A.3	a. Identify those indicators that are relevant to more than one objective	☐
	b. Assess the relevance of indicators and rate them based on the criteria listed in Worksheet A-2	☐
	c. Prioritize a subset of indicators based on the above criteria	☐
A.4	a. Consider the indicators in the context of a conceptual framework (see Examples A-1/6 as a reference)	☐
	b. Identify the correlations among the indicators	☐

Worksheet B-1 **Estimating costs for conducting the test (based on IFAD, 2003)**

Categories	Specific items
Labour costs - Recurrent (permanent staff salaries; temporary support staff) - Technical assistance contracts (short- or long-term, national, international)	- Planning and developing the M&E system - Conducting regular monitoring - Report writing and analysis - Participating in review processes and events - Information management - Capturing and documenting lessons learned - Disseminating M&E findings - Supporting community based/participatory M&E processes
Physical non-contractual investment costs	- Equipment for monitoring - Communications and presentation equipment - Establishment of M&E offices (e.g., furniture, equipment) - Publication materials - Computers and software - Vehicles
Non-labour operational costs	- Vehicle fuel and maintenance and other transport - Office running costs (overheads, maintenance) - Stationery - Meetings - Allowances for primary stakeholders and project implementers - External data, such as maps - Communication and publication costs – printing/copying documents, editing, layout and publication of key documents
Training and study tours for M&E-related capacity-building	External and on-site training courses: - Training of primary stakeholders to build capacity in M&E - Training of selected implementing partners concerned with community development on introducing and supporting participatory monitoring - Training selected M&E staff of service providers (government and NGO) on relevant M&E aspects - Training M&E officers and key management staff on M&E, including computer training - Financial management training, as appropriate - Promoting exchange of experiences with other projects, among the different stakeholder groups - Course fees

Example B-1 Workplan and timeline of Xiamen ICM project

ID	Task	Time (d)	Nov. 2005	Dec. 2005	Jan. 2006	Feb. 2006	Mar. 2006
1	**1. Selection of indicator**	10					
2	1.1 Selection and prioritization	7					
3	1.2 Relationship among indicators	7					
4	1.3 Listing of indicators	0					
5	**2. Assessment planning**	20					
6	2.1 Identify data sources	14					
7	2.2 Assessment of resource needs	7					
8	2.3 Identifying target users	2					
9	2.4 Organization of task team	3					
10	2.5 Development of workplan	7					
11	2.6 Complete workplan	0					
12	**3. Assessment**	60					
13	3.1 Collect and compile data	56					
14	3.2 Analysis of data	14					
15	3.3 Assessment of data	7					
16	3.4 Data assessment	0					
17	**4. Exchange of outcomes**	30					
18	4.1 Outcome sharing	14					
19	4.2 Compilation of report	32					
20	4.3 Submission of final report	0					

Example B-2 Monitoring and evaluation matrix (based on IFAD, 2003)

Performance questions and related targets	Information needs and indicators	Baseline information: requirements and status	Data gathering: methods, frequency, responsibilities	Planning and resources: forms, planning, training, data management, expertise, responsibilities	Information use: analysis, reporting, feedback, change processes, responsibilities

Checklist B **Planning the test of the indicators**

Step	Task	Completed
B.1	a. Identify the sources of data for the indicators	☐
	b. Assess coverage and quality of data	☐
B.2	a. Determine the human resources needed for measuring and analysing the indicators	☐
	b. Determine the equipment needed for measuring and analysing the indicators	☐
	c. Estimate the budget needed for applying the indicators	☐
	d. Assess the budget needed against the resources available and decide whether additional resources are to be secured	☐
B.3	a. Determine the audience for the results of the test	☐
	b Prioritize the audience for the results of the test	☐
B.4	a. Determine the level of expertise required for carrying out the test	☐
	b. Determine the in-house availability of resources for carrying out the test and, if needed, hire external consultants	☐
	c. Decide whether to involve stakeholders and establish the team to conduct the test	☐
B.5	a. Determine the time needed to conduct the test	☐
	b. Determine when to conduct the test	☐
	c. Develop a work plan and timeline	☐

Example C-1 **Typology of data representation**
Graph: Evolution of species richness, density and diversity

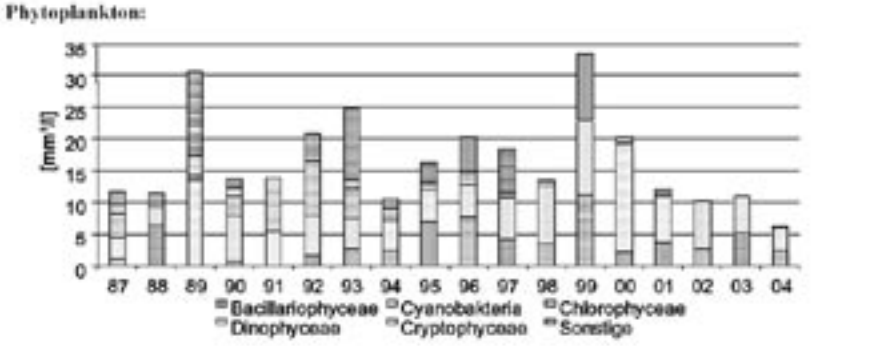


Figure 2.5: Phytoplankton composition in summer in the Kleines Haff (Oder Lagoon) between 1987 and 2004. The species are aggregated into six major taxonomic groups. Data source: State Agency of Environment, Protection of Nature and Geology Mecklenburg-Vorpommern (LUNG).

Table 1 **Change in abundance of Chinese White Dolphin in Xiamen waters**

Date	Number of Survey vessels	Navigational miles (km)	Hours for survey	Number of dolphin found
1994	1	35	3.2	5
1996	2	55	7.5	5
1997	13	395	58	114
1998	35	1453	145	122
1999	36	1073	137	144
June 2003–May 2004	56	1900	260	123

From Xiamen ICM project report, page 24
Source: Beijing Normal University and Xiamen Environmental Protection Bureau (2005), Research Report No. 6 for Planning of Building Xiamen into an Eco-City: Marine Ecological Construction and Environmental Protection

Qualitative data **Level of stakeholders' participation (in the form of questionnaire)**

"Do you participate in the educational activities related to ICOM?"

"Always"	☐
"Frequently"	☐
"Sometime"	☐
"Never"	☐

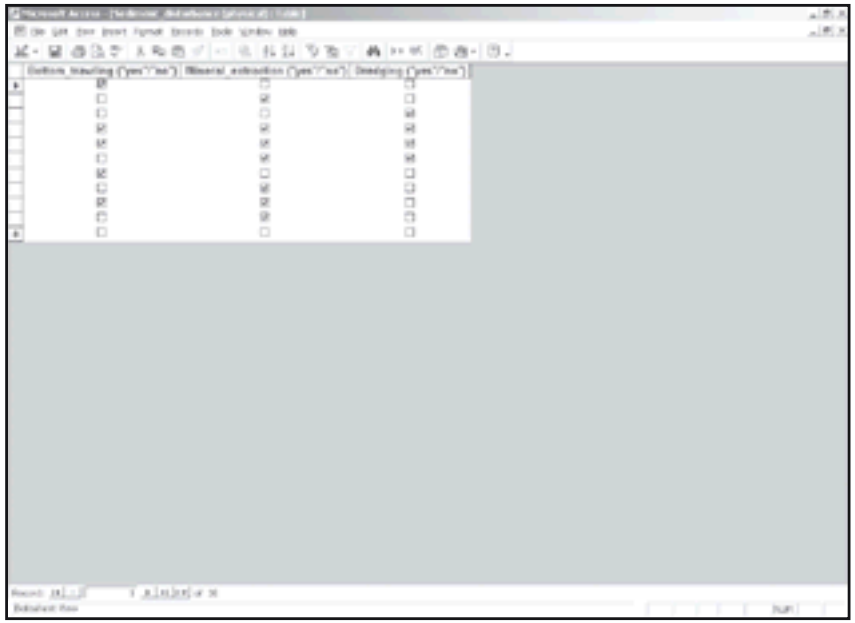
Example C-2 CHARM test project application of ecological indicators based on the IOC Guidelines for Vulnerability Mapping in the Indian Ocean (IOC-UNESCO, 2000) and the South Pacific Applied Geoscience Commission (SOPAC, 1999) Environmental Vulnerability Index (EVI).
Indicator used for the calculation of EVI for coastal units in Ban Don Bay and Phang Nga Bay.

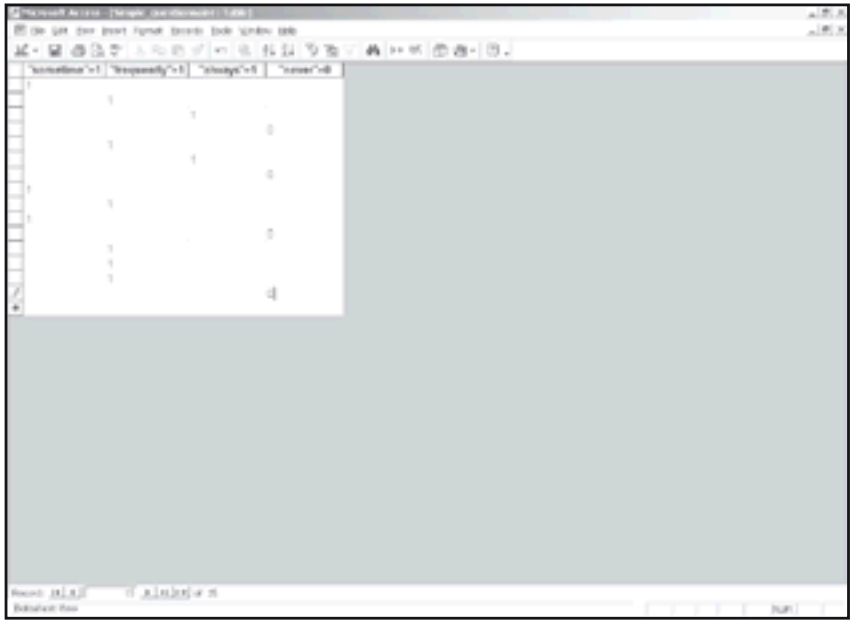
No.	Sub-index	Wt. factor1	Indicator (Universal indicator)										
			Name	Description	Unit	Significance on natural resource/ environment	Scoring level for raw data						
							1	2	3	4	5	6	7
1	IRI2	3	Land area	Round figure of land area (sum of sub-district area).	Sq. km.	Land area signals richness of habitat types, refugia, species redundancy and richness. Therefore large area is normally more stable than the small area. Certain risks might cause small area to be more vulnerable.	> 600	501 – 600	401 – 500	301 – 400	201 – 300	101 – 200	≤ 100
6	EDI3	1	Alien species	All introduced species.	No. of species	Biodiversity, since poses threats to local species.	N/A	N/A	N/A	N/A	N/A	N/A	N/A
8	RDI4	1	Migrating Species	Number of known outside species that migrate in the coastal unit during their life spans (including marine species)	no. of species	Lack of determination of welfare of species while they are outside the country's control. Various sites of the migrating species are conserved as tourist attraction spots.	≤ 35	36 – 40	41 – 45	46 – 50	51 – 55	56 – 60	> 60

Source: Modified from Progress Report: Global Environmental Vulnerability Index (EVI): Initial testing of the Global EVI, 2002

1 high = 3, medium = 2, low = 1
2 IRI = Intrinsic resilience descriptors = natural resilience of a system based on its innate characteristics; characteristics of natural systems that make them more or less able to cope with natural or anthropogenic hazards. High IRI represents high risk or more vulnerable. IRI is not negotiable.
3 EDI = Environmental Degradation descriptors = damages sustained by the natural systems as a signal to predict how well those systems might (extrinsic resilience) be able to resist damages from future hazards. High EDI represents high stress or more vulnerable.
4 REI = Risk exposure descriptors = frequency and intensity of potential risks of natural and anthropogenic hazards. High REI represents high risk or more vulnerable.

Example C-2 Data Coding





Checklist C **Conducting the test**

Step	Action	Completed
C.1	a. Implement the work plan	☐
C.2	a. Familiarize with data collection/compilation methods	☐
	b. Assess the availability of data	☐
	c. If necessary, select a sample	☐
	d. Collect/compile data	☐
C.3	a. Determine person in charge of data management	☐
	b. Code data and transfer to the person in charge	☐
	c. Enter and store data	☐
	d. Collate and review data sets	☐
	e. Determine how to make data available	☐
C.4	a. Review the data	☐
	b. Undertake a preliminary analysis	☐
	c. Complete final analysis	☐
	d. Prepare results	☐
C.5	a. Submit results to peer reviewers	☐

Worksheet D-1 **Format for reporting on the testing of the indicators**

A total of about 20-25 pages (including tables, figures, and references), plus the introduction (care of IOC)

Component	Completed
Introduction	☐
Background information (about 7-8 pages)	
Ecological characteristics	☐
Socioeconomic environment	☐
Goals and objectives	☐
Institutional arrangements	☐
Legal framework	☐
Management plan	☐
Staff	☐
Outreach and training	☐
Stakeholder participation	☐
Major issues	☐
Key outcomes	☐
Need for, and context of, the evaluation	☐
Existing monitoring and evaluation activities	☐
Applying the handbook (about 10-12 pages)	
Selected indicators	☐
Evaluation work plan	☐
Implementation of the work plan: human resource effort (and associated costs)	☐
Strengths and limitations of the indicators	☐
Results from the evaluation (including use of tables and graphs)	☐
Lessons learned (about 3-5 pages)	
Identifying and measuring the indicators	☐
Implications for management	☐
Recommendations	☐
References	☐

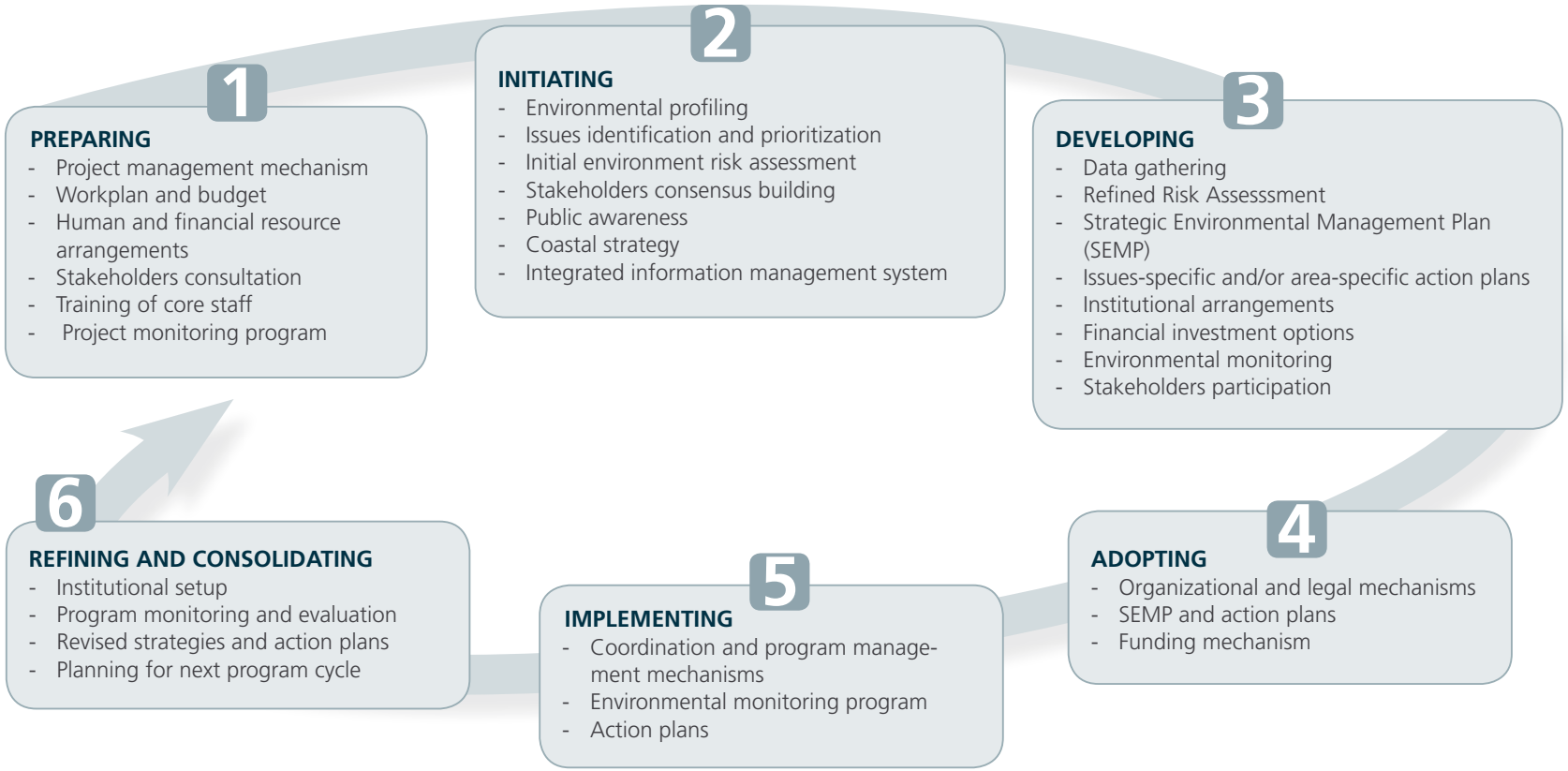
Worksheet D-2 **Examples of indicators important for different stakeholders**

		Indicator 1	Indicator 2	Indicator 3	Indicator 4	Indicator 5	Indicator 6	Indicator 7	Indicator 8	Indicator 9	Indicator 10
Stakeholders	Issues										
Fishermen	Issue 1										
	Issue 2										
	Issue 3										
Tourism and recreation	Issue 4										
	Issue 5										
	Issue 6										
Shipping and port	Issue 7										
Aquaculture	….										
Landowners	…..										
Entrepreneurs with businesses near the coast	…..										
Users of coastal and upland resources	…..										
Universities and research Institutes	…..										
NGOs	….										

Example D-1 Communication strategies for a target audience

One-way communication	Two-way communication
- Written materials (report, papers) - Visual material (posters, pictures) - Oral presentation (in person) - Mass media - Internet (World Wide Web)	- Group discussion - One-on-one discussion - Physical and electronic bulletin - Remote communication - Internet (email)

Example D-2: Performance assessment framework proposed by Chua et al. (2003)



*This framework has been adopted in Xiamen ICM project report in the context of the evaluation of Cycles I and II of the project.

Checklist D **Communicating results**

Step	Action	Completed
D.1	a. Format results according to the IOC suggested format	☐
D.2	a. Develop a strategy and a timeline for disseminating results to a variety of audiences	☐
	b. Disseminate results	☐
D.3	a. Consider how to incorporate the results of the test in daily management activities	☐
D.4	a. Consider how to institutionalize the monitoring and evaluation system developed for the test and make it sustainable	☐

7 Summary, lessons learned and recommendations

1. Introduction

The preceding chapter on applying the indicators has provided outcomes, suggestions and examples from the application of governance, ecological and socioeconomic indicators in the ICOM case studies. This has enriched the process of indicator selection and application. In general, the case studies found that the handbook has provided useful perspectives by which progress in the implementation of ICOM projects and initiatives can be assessed (Box 7-1).

This chapter presents a brief summary of the experiences and main outcomes of these test projects, as well as lessons learned and recommendations of a more general nature. Users of the handbook will benefit greatly from the experience gained in the case studies, and are urged to refer to the reports of the individual case studies for further information and details (http://ioc3.unesco.org/icam/).

7.2 Main findings and lessons

Applicability of the indicators

The case studies demonstrated the applicability of the ICOM indicators under different ecological, socioeconomic and governance scenarios and conditions (Table 7-1). For instance, the management units/ecosystem types included offshore areas (Canada), coastal lagoon (France), mangrove forests (Thailand), coastline (Chile) and nearshore estuarine areas (Germany). The socioeconomic conditions and economic activities ranged from oil and gas extraction industries in the case of Canada, to tourism and artisanal fisheries in the case of China and Thailand.

The scale of the test projects spanned national, regional and local levels, with the existence of specific plans of action enabling ICOM, such as coastal management plans or legislation related to coastal management. In most cases, the coastal management projects were initiated by national directives and legislation. For example, the Canada ESSIM and Chilean projects are national coastal management programmes, which include legislation and coordinating bodies at the national level. In the German study, indicator selection was based on the EU Water Framework Directive at the national level. The CHARM project was based on directives from sub-district government offices at the Thai provincial level (Tambon Administrative Office), and the project adopted a strategy consisting of developing a "nested governance system", whereby management power and responsibility are shared cross-scale among a hierarchy of management institutions. The CHARM project integrated the ICOM indicators, particularly the ecological indicators, with the application of the approach based on the IOC Guidelines for Vulnerability Mapping in the Indian Ocean (IOC-UNESCO, 2000) and the South Pacific Applied Geoscience Commission (SOPAC, 2002) Environmental Vulnerability Index (EVI) (see examples in Chapter 6).

The ICOM indicators were also applied in cases where an ICOM initiative did not explicitly exist. For instance, in Chile, there was no existing ICOM project to start with, although the elements of ICOM were already conceptually contained within the rules and instruments that regulate the use of coastal spaces. This was also the case for the Oder Estuary project, where several activities supported ICOM aims, or could have even practically implemented an ICOM approach, without explicitly mentioning this term. In the case of Chile, the key assumption was that as long as the management incorporates the essential ICOM aspects, the resulting intervention would lead to an improvement in environmental quality while threats to users and the environment will tend to decrease.

Relationship among governance, ecological and socioeconomic indicators

The linkages among the three types of indicators are well illustrated in the DPSIR framework, which has been discussed in preceding chapters. In the policy cycle, governance indicators are representation of driving forces and response. In this framework it is clear that the measurement of governance status could be highlighted throughout the policy cycle, through the analysis of initial conditions, preparation, implementation, evaluation and adjustment steps. Ecological indicators deal more with state and impacts, while socioeconomic indicators relate to driving forces and pressures. These two types of indicators are essential to understanding the effectiveness of an ICOM programme or plan, or in which direction it should be enforced or adjusted. In this regard, before selecting and applying the indicators, it is important that the goals and objectives of the management programme be developed in relation to the environmental and socioeconomic context of the country or region under examination.

The elucidation of dependencies among the components of the DPSIR framework is often a challenge. For instance, in the Oder project, changes in drivers in the river basin and changes in the pressure "nutrient loads" do not cause significant changes in the state of the lagoon or in water quality. This is be-

cause most of the time, nutrients are available in high concentrations and do not limit primary production, i.e., phytoplankton does not show a close relationship to water quality in the lagoon. This underscores the need for careful selection of the indicators and their parameters and measurements, and for some prior knowledge about the environmental features of the management area.

Application of indicators

The joint application of governance, ecological and socioeconomic indicators gives a more comprehensive understanding of the dependencies in a coastal or marine system. In the CHARM project, incorporating the three types of indicators into the framework of the ICOM policy cycle was considered essential. This makes it easier to understand that indicators are iterative all along the ICOM process and also to develop among them specific linkages related to the stage of development of any ICOM initiative.

A broad knowledge base is required for joint application of the three types of indicators. Moreover, the ease of application and data and information requirements of the three types of indicators vary. Application of governance indicators can be developed from existing documents, laws, regulations and frameworks relevant for the region. It is, however, important to consider governance indicators within the context of the different steps of the ICOM policy cycle. As pointed in the Oder project, the processing, answering and evaluation of the governance indicators in the absence of an explicit ICOM initiative requires careful analysis.

Ecological and socioeconomic indicators require a particular effort in applying the structure of the indicator itself to the distinctiveness of the different ecological and socioeconomic realities of the countries or regions (ecosystem types, cultural background, relationship among ecosystem dynamics and human activities, economy and exploitation of marine resources, etc.). These peculiarities must be taken into consideration when selecting the indicators, as has already been noted. Nevertheless, the directly applicable indicators were found to be the ecological indicators by the Oder project, since they directly provide information about the ecological status of the ecosystems. The socioeconomic and governance indicators were also found to be useful by the Oder project. These indicators are clearly valuable in providing a more comprehensive picture of the entire coastal system with all its dependencies. For instance, they can help to allocate the causes of the problems, i.e., show the reasons why a good ecological status cannot be achieved. A good coverage and quality of data is required to quantify the ecological and socioeconomic indicators.

In Chapter 2, the establishment of ICOM goals and objectives were discussed. In the Wadden Sea project, environmental targets, objectives or goals were defined as a desired future state of the environment, to be reached within a certain period of time. Indicators were defined as parameters that provide information about the target, relevant for decision-making processes necessary for implementing the targets. However, the difference between targets and indicators is sometimes unclear. For example, salmon back in the Rhine in a particular year can be both a goal in itself and an indicator of the overall environmental quality of the river.

A problem encountered was the interpretation of the results. A biodiversity of 10, for example, does not indicate if it is 'good' or 'poor', and a classification scheme to interpret this to motivate action is needed. This also emphasizes the need for baseline data to help with interpretation of the results. Strategies, how to link the results of indicators, as well as classification schemes defining a very good, good or poor state are lacking so far. This reduces the acceptance of indicator sets, makes it difficult to communicate shortcomings in the environmental and/or management situation and to motivate concrete actions by decision-makers.

The application of such a wide range of indicators should be carried out by an interdisciplinary working group. Governance indicators in particular have to be applied in close cooperation with regional authorities and experts, to yield reliable and generally accepted results.

Defining the ecosystem/management area boundaries

ICOM promotes ecosystem-based management, but a challenge is how do we define the ecosystem and its boundaries? In the Xiamen project, it was pointed out that it is often not easy to define the boundaries or that they are overlapping. This project found that it is more important to look into the habitats, especially the spawning and nursery grounds, from where recruitment originates. Likewise, the Canada ESSIM project noted that formal designation of coastal and marine areas for which ecological objectives are to be set is one of the major hurdles that needs to be overcome in implementing ICOM. Furthermore, designation of management areas should be seen as a step that requires progressive and incremental development as knowledge and experience becomes available. It was felt that it is the role of ICOM managerial and coordinating mechanisms, rather than of scientists, to undertake this designation.

Data collection and monitoring

The development of indicators and their use in evaluating progress is dependent on a data and information management and reporting system for use by decision-makers. This aspect is often one of the major weaknesses of integrated initiatives. There are several challenges in the preparation of the required data and in quantifying the indicators. For instance, there are problems due to spatial and temporal heterogeneity in faunal communities, which limits the representativeness of data from one sampling station or point in time. Most parameters show a temporal variability, and averaged data are required.

Production, reproduction and trophic interactions need a very strong input from scientific studies. The Xiamen project found recruitment to be a key parameter. Concerning genetic diversity, the Xiamen projected also noted that at the local level, the emphasis should be on the keystone species or the dominant species.

In the Wadden Sea, it was decided to focus on habitat conditions (physical, chemical and biological). This was based on the premise that good habitat quality promotes natural increases in biodiversity.

Undertaking comprehensive monitoring of a high number of indicators, especially in large management areas, may not always prove feasible. One practical approach to address this problem is the development of a habitat classification system, e.g., benthic and pelagic – see WWF (2005) - that then allows indicators to be developed and monitored for selected representative habitats that are linked to the ecosystem objectives. For the setting up of a monitoring system, it is practical to develop a reductionist approach to ICOM indicators. Based on the experience of the test projects and further analysis, a subset of key governance, socioeconomic and ecological indicators of wide application is proposed (Table 7-2).

As highlighted in Chapter 2, the selection of the indicators for the tests was guided by the five different frameworks mentioned in the handbook (DPSIR, Policy Cycle, Logical Framework, Outcome-based approach and Ecosystem-based approach). The selection of the indicators included in this proposed subset was based on the effectiveness of the indicators themselves in relation to the measures required in the application of these different frameworks (see Table 2-6 in Chapter 2 and examples in Chapter 6).

Moreover, the subset of indicators has been selected in relation to the outcomes and recommendations provided by the case studies. In the subset of governance indicators, it is important to note the relevance among the indicators G1, G2, G4, G5 and G7, commonly applied by the tests, in order to assess the existence or the state of legislation, coordination and management in ICOM. Moreover, the subset of governance indicators includes the indicators measuring the stakeholder involvement and effort in ICOM (G10) and the available resources enabling ICOM (G8). G8 could include information dealing with other related indicators, such G9 (Inputs from scientific research) or G12 (Education and training).

In relation to the ecological indicators, the case studies highlighted the importance to draw a frame of the ecological state of the country or the area involved, through essential information on biodiversity and environmental quality (E1, E8 and E9). The indicator E9 - Habitat quality could include information on SE5 – Human pressures on habitats.

The subset of the socioeconomic indicators includes those indicators useful in measuring the general social condition within ICOM intervention (SE 1, SE 3

and SE 9) and the state of human health and activities in relation to anthropogenic impacts (SE 7). Included in this subset is a "cultural" indicator to measure the level of protection and conservation of the coastal cultural heritage (SE13); the case studies experience pointed out the importance of cultural heritage and behaviour as an influencing element in ICOM effectiveness.

While the complete set of the three types of indicators offers a wide choice to measure ICOM initiatives in relation to specific geographical and institutional contexts, careful customization is needed to tailor primary and secondary indicators to avoid overlaps in the indicators.

Whenever possible, the format for data and information should be standardized and harmonized, in order to allow comparability among different areas, regions or countries. This should take into account the different levels of socio-economic development and geographical location of the management area, region or country.

Some factors influencing the ICOM process

The application of indicators by the test projects drew attention to the most important issues that influence the effectiveness of an ICOM plan, especially related to governance aspects such as policies, legislation, institution, resources and stakeholder involvement and behavior. This makes it possible to focus attention on issues and activities that need adjustment following the evaluation to contribute to the further development of the ICOM programme.

Legislation alone is not adequate to provide a true enabling environment for the implementation of ICOM. There is a need for a sequence of supportive activities that reinforce and promote the legislation and its application. For indicators to be effective, they must be systemically incorporated as a management tool within the appropriate agency.

The ICOM effort requires a programme of adaptive management, with progressive reinforcement by leadership at all levels of government and an ultimate shift from the previous sectoral "business as usual" approach to one where integration is improved. It is important to integrate all efforts from various sectors and to combine the "up-down" and "down-up" approaches, rather than concentrate all powers into one agency.

The measurement of progress and outcomes of ICOM by the test projects highlighted several other important facets, such as the awareness in society of the need for change on the one hand and of stakeholder behavior that often resists change on the other. Measuring progress in ICOM is also about measuring changes in the behaviour of people and organizations. The pace of change is dictated by two main opposing forces, one of which is resistance to change (s) by certain stakeholders, particularly those that are likely to be most affected; and the other is the desire by society to see that changes occur. The ICOM effort therefore requires a programme of "change" management. To be successful, it is implicit that there should be a change in the behaviour of stakeholders. Government agencies are the prime drivers of change. They can, however, also be the main source of resistance as many of them, by virtue of their mandates, serve the stakeholder sectors that will be most affected by change.

The pace of change is not constant and tends to progress in a stepwise fashion as particular "hurdles" are overcome or "doors" are opened. It is important to proactively identify these "hurdles" and "doors" and treat them as priority areas for action. Progress and performance should also be based on how these "doors" and "hurdles" are addressed. Both successes and failures should be noted and acted on by decision-makers.

Box 7-1 Some components from the case studies

- **Canada**: It was possible to provide a substantial description of the ESSIM initiative using the ICOM indicator attributes as a framework. … The handbook has allowed for the identification of issues and activities that will require more focus and attention by ESSIM in its future development.
- **Chile**: …it is highly stimulating that our country had the possibility, from our rudimentary attempts on integrated coastal zone management, to collaborate, on a first stage, on the conceptual validation of the above indicators; and, on a second stage, on their practical validation. … this experience rather than delivering answers has placed our attention on questions that would have otherwise been overlooked in our desire to move forward, in the face of a reality that imposes its own pace, as is the case for coastline occupation.
- **China**: All the attributes that the IOC recommends for use in evaluating ICOM progress and performance are relevant to Xiamen-ICM.
- **Germany**: Governance indicators consist of concrete questions and describe a process.… Generally, their application does not require much time and resources…. Ecological and socioeconomic indicators are quite different compared to governance indicators and their application is much more complicated and time-consuming. … A reliable and accurate indicator application is necessary to ensure reproducibility and to be able to measure the progress from one application to another (carried out later).
- **Thailand**: …a major improvement has been proposed consisting of incorporating the use of the different types of indicators into the framework of the ICOM policy cycle... Put into such a dynamic perspective, it becomes much easier to understand that indicators are iterative all along the ICOM process but also develop between them specific linkages related to the stage of development of any ICAM or ICOM initiative… it becomes possible using the handbook through a double entry system: consider the indicators in relation to the coastal management cycle, and/or focus more specifically on one of the ICAM attributes, be it related to the Governance, Ecological, or Socioeconomic domains.

External monitoring of performance, and objective reporting, at the highest level of governance (e.g., Canadian Parliament) is also important, since ICOM, even at the local level, requires the integration of the efforts of many national agencies and institutions.

At an early stage in ICOM, it would be useful to have a national formal ICOM "guru" who plays the role of synthesizer, advisor, mentor and promoter on matters relating to ICOM and its development. Coordinating mechanisms (committees and advisory boards) with stakeholder representation are useful for the dissemination of information, solicitation of opinion, and decision-making, but they are not in a position to provide the specialized opinion, support and advice that such a position would bring to the table.

7.3 Recommendations

From the experience of the case studies, it is possible to draw some general recommendations for further development and application of the ICOM indicators by managers.

- The strategy on how to apply the indicators and how to involve local/regional stakeholders depends very much on the cultural background of the country or area in question. Documentation and evaluation of different strategies would be beneficial when devising a monitoring and evaluation system.
- The importance of considering the various frameworks before selecting the indicators cannot be underestimated. The selection of the indicators should be preceded by the analysis of different analytical frameworks. In this way, it is possible to identify the key issues and elements that need to be analysed within the framework of the programme examined, and bring about a more effective selection and analysis of the indicators to be applied.
- Focusing on the attributes associated with the phases of the cycle of ICOM will provide a reference framework. For early phase initiatives, which are in the process of being developed and bringing stakeholders to the discussion table, the focus of stakeholders and facilitators will be on the progress associated with the first-order outcomes for the setting up of the necessary processes and systems. Little attention will be given to later stages until the parties are ready. In most cases, ICOM is under development (or implicitly tackled by existing legislation) and will be a continuous process. At present, the indicators proposed by IOC are focused on an existing ICOM initiative.

- The indicators aim to evaluate existing instruments and approaches, and reflect both the progress in the implementation of ICOM and the final results. This is especially true for governance indicators. Desired socioeconomic and ecological changes, however, take time and the introduction of ICOM and the measurement of its progress will involve a timeline of decades rather than years or one cycle. Therefore, criteria should be established by the users for the assessment of progress for different cycles.
- World-wide or trans-regional comparisons based on a few pre-selected indicators could motivate interested users to apply indicators in their region and could support the dissemination of the ICOM indicators. Applications of similar indicators in different countries or areas would allow comparisons, and the case studies could learn from teach other.
- The application of indicators requires a sound understanding of their definition and description. To enhance the acceptance and applicability of indicators and the accuracy of their application worldwide, IOC is considering the translation of the handbook in major languages.

In conclusion, ICOM indicator application and evaluation is an ongoing process, with growing experience. Regional networks of coastal managers are being considered to give continuity to the indicator applications in existing and new case studies, to help promote the indicators and to maintain an exchange of ideas and experiences in ICOM indicator applications.

Table 7-1 Resume of ecological, socioeconomic and governance outlooks of the case studies

Case study	Ecological Study area and marine ecosystem	Main socioeconomic activities and stakeholders involved	Governance National / Regional / Local level Legislation/Framework
Canada	Offshore area Living and non-living marine resources, high biological diversity	Fisheries, offshore oil and gas, shipping, maritime defence operations, submarine cables, conservation, research and development, tourism, potential offshore minerals development.	National Federal Governance Framework
Chile	Oceanic and littoral ecosystems	Industrial and non-industrial fishing, aquaculture, manufacturing, port services. Urban concentration characterized by high population density and scarcity of water resources.	National Ministry of Defence, Undersecretary of Marine
Germany	Estuarine area Coastal zone dominated by the discharge of the river Oder into the Szczecin Lagoon	High unemployment. Tourism, shipping, cattle-breeding, fisheries.	Regional European Water Framework Directive Marine Strategy Recommendations on ICZM Habitat Directive (Natura, 2000)
China	Nearshore area Internal bay, estuary and island ecosystems	Tourism, cultural and educational exchanges, fisheries and urban development on coasts.	Regional Sea Area Use Management Law of the People's Republic of China (PEMSEA, 2003)
Thailand	Extensive mangrove forests, marine protected areas, marine parks	Fisheries, aquaculture and tourism.	Local Local Government Units (suffer from a lack of capacity to service delivery, budgeting, accounting)
Wadden Sea Trilateral Cooperation	Coastal marine wetland	Shipping, tourism, fishery, military activities, extraction of sand and dredging.	Multinational Trilateral cooperation among Denmark, Germany, and the Netherlands
France	Coastal lagoon (in progress)	Tourism, shellfish cultivation, aquaculture. Syndicat Mixte manager, professionals, scientific community.	Regional. Legal basis: French law
Tanzania	Territorial waters, EEZ (in progress)	Private sector. Coastal communities and civil societies.	National EEZ Governance and Facilitation Team

Table 7-2 A sub-set of ICOM Indicators

Governance	G1 Coordinating mechanism	G2 Legislation enabling ICOM	G4 Conflict resolution mechanism	G5 Integrated management plans	G7 Monitoring and evaluation	G8 Human, technical and financial resources	G10 Stakeholder participation
Ecological	E1 Biological diversity	E8 Water quality	E9 Habitat quality				
Socioeconomic	SE 1 Total economic value	SE 3 Total employment	SE 6 Pollutants and introductions	SE 9 Population dynamics	SE 13 Protection of coastal heritage resources		

References

AidEnvironment/RIKZ (2004). *Integrated Marine and Coastal Area Management (IMCAM) approaches for implementing the Convention on Biological Diversity*. CBD Technical Series no. 14. Secretariat of the Convention on Biological Diversity, Montreal.

Belfiore, S. (2005). *Using Indicators for Improving the Performance of Integrated Coastal Management Efforts: Towards a Common Framework*. Doctoral dissertation, University of Delaware.

P.C. Beukenkamp, Günther, P., Klein, R.J.T., Misdorp, R., Sadacharan, D. and de Vrees, L.P.M. (eds.), 1993. *Proceedings of the World Coast Conference, Noordwijk, The Netherlands, 1-5 November, 2003*. CZM-Centre Publication 4, Coastal Zone Management Centre, The Hague, The Netherlands.

Bowen, R.E. and Crumbley, C. (1999). Evolving Principles in Coastal Management: From Concept to Action. In D.L. Soden & B.S. Steel (Eds.), *Handbook of Global Environmental Policy and Administration*. Marcel Dekker, New York.

Bowen, R.E. and Terkla, D. (1990). *The Massachusetts Bays Management System: A Valuation of Bays Resources and Uses and an Analysis of its Regulatory and Management Structure: Part I, Determination and Benefit Valuation of the Uses and Resources of the Massachusetts Bays.* MBP-93-01. The Massachusetts Bays Programme, Boston.

CBD (2004). *Integrated Marine and Coastal Area Management (IMCAM) Approaches for Implementing the Convention on Biological Diversity*. CBD Technical Papers 14. CBD, Montreal. Available at http://www.biodiv.org/doc/publications/cbd-ts-14.pdf.

CBD/COP (1998). Report of the Workshop on the Ecosystem Approach, Lilongwe, Malawi, 26-28 January 1998. CBD, Montreal.

Chua, T. E. (1993). Essential elements of integrated coastal management. *Ocean & Coastal Management*, 21: 81-108.

Chua, T., Lee, J. Yu, H. and Ross, A. (2003). Measuring the performance of integrated coastal management programmes. *Proceedings of the International Conference on the Sustainable Development of the Seas of East Asia: Towards a New Era of Regional Collaboration and Partnerships*.

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

Cicin-Sain, B., Ehler, C.N., Knecht, R., South, R. and Weiher, R. (1997). *Guidelines for Integrating Coastal Management Programs and National Climate Change Action Plans. Developed at the International Workshop: Planning for Climate Change through Integrated Coastal Management, February 24-28, 1997, Chinese Taipei*. N.p. Available at http://www.globaloceans.org/guidelines/PDF_Files/Taipei.pdf.

Costello, M.J., Pohle, G. and Martin, A. (2001). Evaluating Biodiversity in Marine Environmental Assessments. CEAA Research and Development Monograph Series, 2001; Canadian Environmental Assessment Agency. Available at: http://www.ceaa.gc.ca/015/001/019/index_e.htm

Commission on Sustainable Development (CSD), United *Nations (1996). Indicators for Sustainable Development: Framework and Methodologies*. United Nations, New York.

EEA (1998). *Europe's Environment: The Second Assessment*. EEA, Copenhagen. Available at http://reports.eea.eu.int/92-828-3351-8/en.

EEA (2000). *Questions to be Answered by a State-of-the-environment Report: The First List*. EEA, Copenhagen. Available at http://reports.eea.eu.int/Technical_report_No_47/en.

Epstein, P.R. (1996). *Changing coastal/marine environments and human health*. Ecosystem Health 2(3): 166-176.

ETC/TE (2004). *Measuring Sustainable Development of the Coast: A Report to the EU ICZM Expert Group by the Working Group on Indicators and Data Led by the ETC-TE. ETC/TE*, Brussels.

GESAMP (2001). *Protecting the Oceans from Land-based Activities: Land-based Sources and Activities Affecting the Quality and Uses of the Marine, Coastal and Associated Freshwater Environments.* GESAMP Reports and Studies 71. GESAMP and ACOPS, London. Available at http://gesamp.imo.org/no71/.

Henocque, Y. and Denis, J. (2001). *Steps and Tools towards Integrated Coastal Area Management: Methodological Guide Volume II.* IOC Manuals and Guides 42. UNESCO, Paris.

Henocque, Y. and Tandavanitj, S. (2006). *Measuring the progress and outcomes of Integrated Coastal and Ocean Management: The CHARM project case study in Southern Thailand*. Report to the Intergovernmental Oceanographic Commission.

Hinrichsen, D. (1998). *Coastal Waters of the World: Trends, Threats, and Strategies*. Island Press, Washington, D.C.

IFAD (2003). *Managing for impact in rural development*. A Guide for Project M&E. IFAD, Rome.

IOC-UNESCO (2000). *Guidelines for vulnerability mapping of coastal zones in the Indian Ocean*. Manuals and Guides No. 38.

IOC (2003a). *A Reference Guide on the Use of Indicators for Integrated Coastal Management*, prepared by S. Belfiore, M. Balgos, B. McLean, J. Galofre, M. Blaydes, and D. Tesch. Manuals and Guides 45. UNESCO, Paris.

IOC (2003b). Coastal Panel of the United Nation's Global Ocean Observing System (GOOS). *The Integrated Strategic Design Plan for the Coastal Observations Module of the Global Ocean Observing System*. GOOS Report No. 125. IOC Information Documents Series, No. 1183.

IOC (2005). Coastal Panel of the United Nation's Global Ocean Observing System (GOOS). *An Implementation Strategy for the Coastal Module of the Global Ocean Observing System*. GOOS Report No. 148. IOC Information Documents Series, No. 1217.

IWICM (1996). The International Workshop on Integrated Coastal Management in Tropical Developing Countries: Lessons Learned from Successes and Failures. *Enhancing the Success of Integrated Coastal Management: Good Practices in the Formulation, Design, and Implementation of Integrated Coastal Management Initiatives.* MPP-EAS Technical Report 2. Quezon City, Philippines: GEF/UNDP/IMO Regional Programme for the Prevention and Management of Marine Pollution in the East Asian Seas and the Coastal Management Center. Available at http://www.globaloceans.org/guidelines/PDF_Files/good_practices.pdf.

Jong de, F. (2006). *The Trilateral Wadden Sea Cooperation and Integrated Coastal Zone Management*. Report to the Intergovernmental Oceanographic Commission.

Karr, J.R. (1981). Assessment of biotic integrity using fish communities. *Fisheries*, 6: 21-27

Knap, A., Dewailly, E., Furgal, C., Galvin, J., Baden, D., Bowen, R.E., Depledge, M., Duguay, L., Flemming, L., Ford, T., Moser, F., Owen, R., Suk, W.A. and Unluata, U. (2001). Indicators of ocean health and human health: A research framework. *Environmental Health Perspectives*, 110: 839-845.

Marvin, C., Grapentine, L. and Painter, S. (2004). Application of a sediment quality index to the lower Laurentian Great Lakes. *Environmental Monitoring and Assessment*, 91: 1-16.

Mayne, J. (1999). *Addressing Attribution Through Contribution Analysis: Using Performance Measures Sensibly*. Ottawa: Office of the Auditor General of Canada. Available at http://www.oag-bvg.gc.ca/domino/other.nsf/html/99dp1_e.html/$file/99dp1_e.pdf.

National Commission on the Use of the Chilean Coastline (2006). *Experience Validation Report to the "Handbook For Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management" in the framework of the Chilean Coastline Management*. Report to the Intergovernmental Oceanographic Commission.

NOAA (1998). U.S. National Oceanic and Atmospheric Administration. *Population: Distribution, Density and Growth, by Thomas J. Cullition. NOAA's State of the Coast Report*. Silver Spring, MD. Available at: state-of coast.noaa.gov/bulletins/html/pop_01/pop.html.

NOAA (2004). *The National Coastal Management Performance Measurement System*. NOAA, Silver Spring, Maryland.

NOAA (2005). Spatial Trends in Coastal Socioeconomics (STICS) (2005). *Population Trends along the Coastal United States: 1980-2008*. Available at: http://marineeconomics.noaa.gov/socioeconomics/Assesment/population/welcome.html.

NRC (1999). U.S. National Research Council. *From Monsoons to Microbes: Understanding the Ocean's Role in Human Health*. Ocean Studies Board, National Academy Press, Washington, D.C.

OECD (1993). *OECD core set of indicators for environmental performance reviews*. OECD Environment Monographs, 83. OECD, Paris.

Olsen, S.B. (2003). Frameworks and indicators for assessing progress in integrated coastal management initiatives. *Ocean & Coastal Management*, 46, 347–361.

Olsen, S.B. and Nickerson, D. (2003). *The Governance of Coastal Ecosystems at the Regional Scale: An Analysis of the Strategies and Outcomes of Long-Term Programmes*. Coastal Management Report #2243. ISBN #1-885454-51-1. University of Rhode Island Coastal Resources Centre. Narragansett, RI.

PEMSEA (2003). *The Development of National Coastal and Marine Policies in the People's Republic of China: A Case Study*. PEMSEA Technical Report, 7.

Pickaver, A.H., Gilbert, C. and Breton, F. (2004). An indicator set to measure the progress in the implementation of integrated coastal zone management in Europe. *Ocean & Coastal Management*, 47, 449-462.

Pomeroy, R.S., Parks, J.E. and Watson, L.M. (2004). How is Your MPA Doing? Gland: IUCN.

Rice, J. (2003). Environmental health indicators. *Ocean & Coastal Management*, 46: 235-259.

Rump, P.C. (1996). *State of the Environment Reporting: Source Book of Methods and Approaches*. UNEP, Nairobi.

Salas, F., Marcos, C., Neto, Patricio, J., Pérez-Ruzafa, A. and Marques, J.C. (2006). User-friendly guide for using benthic ecological indicators in coastal and marine quality assessment. *Oceans & Coastal Management*, 49: 308-331.

Schernewski, G., Hoffmann, J., Löser, N., Dreisewerd, M., Stavenhagen, P. and Grunow, B. (2006). *Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management: The German Oder Estuary Case Study*. Report to the Intergovernmental Oceanographic Commission.

Shuvall, H. (2001). *A Preliminary Estimate of the Global Burden of Human Disease Caused by Wastewater Pollution of the Marine Environment*. Report to WHO/GESAMP and summarized in GESAMP (2001a, b).

Small, C. and Nicholls, R. (2003). A global analysis of human settlement of coastal zones. *Journal of Coastal Research*, 19(3): 584-599.

SOPAC (2002). *Environmental Vulnerability Index (EVI) Project: initial testing of the Global EVI*. South Pacific Applied Geoscience Commission. SOPAC Miscellaneous Report 453.

Sorensen, J. (2002). *Baseline 2000 Background Report: The Status of Integrated Coastal Management as an International Practice--Second Iteration* - 26 August 2002. http://www.uhi.umb.edu/b2k/baseline2000.pdf

United Nations (2001). *Road map towards the implementation of the United Nations Millennium Declaration Report of the Secretary-General*. A/56/326. UN General Assembly, United Nations, New York.

UN CSD (1996). United Nations Commission on Sustainable Development. *Indicators for Sustainable Development: Framework and Methodologies*. United Nations, New York.

United Nations and World Bank (2001). *Indicators of Sustainable Development: Guidelines and Methodologies*. United Nations, New York. Available at http://www.un.org/esa/sustdev/natlinfo/indicators/indisd/indisd-mg2001.pdf.

Walmsley, D. and Arbour, J. (2005). *Application of the IOC Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management. The Eastern Scotian Shelf Integrated Management Area: A Canadian Test Case*. Report to the Intergovernmental Oceanographic Commission.

Wells, P.G. (1999). Biomonitoring the health of coastal marine ecosystems – The roles and challenges of microscale toxicity tests. *Marine Pollution Bulletin*, 39: 39-47.

Wilcox, B.A. (1984). In-situ conservation of genetic resources: Determinants of minimum area requirements. In J.A. McNeeley & K.R. Millers (Eds.), *Natural Parks, Conservation, and Development: The Role of Protected Areas in Sustaining Society* (pp. 639-647). Smithsonian Institution Press, Washington, D.C.

WWF (2005). World Wildlife Fund. Classifying and mapping physical habitat types (Seascapes) in the Gulf of Maine and the Scotian Shelf. Available at: http://gmbis.iris.usm.maine.edu/products.asp

Xiamen Taskforce (2006). Xiamen Taskforce of the Application of the IOC Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management (2006). *Application of the IOC Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management. Xiamen Integrated Coastal Zone Management Project: a Chinese Test Case*. Report to the Intergovernmental Oceanographic Commission.

Acronyms and abbreviations

BAP	Best Available Practices
BAT	Best Available Techniques
BPOA	Barbados Programme of Action for Sustainable Development of Small Island Developing States
CBD	Convention on Biological Diversity
CBO	Community-based organization
CCA	Carrying Capacity Assessment
CEIES	Committee on Statistical Information in the Economic and Social Spheres
CoE	Council of Europe
CoML	Census of Marine Life
COOP	Coastal Ocean Observation Panel (GOOS)
COP	Conference of the Parties
CSD	Commission on Sustainable Development (United Nations)
DEAT	Department of Environmental Affairs and Tourism (South African Government)
DESA	Department of Economic and Social Affairs (United Nations)
DFO	Department of Fisheries and Ocean (Canadian Government)
DPSIR	Driving Forces-Pressure-State-Impact-Response
DSR	Driving Forces-State-Response
DTIE	Division of Technology, Industry and Economics (UNEP)
EBM	Ecosystem-Based Management
EC	European Commission
ECOQO	Ecological Quality Objectives
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
ENSO	El Niño - Southern Oscillation
ETC/TE	European Topic Centre for Terrestrial Environment
EU	European Union
EUCC	The Coastal Union
FAO	Food and Agriculture Organization
GESAMP	Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GICS	Global Industry Classification Standard
GIS	Geographic Information Systems
GLCCD	Global Land Cover Characteristics Database
GOOS	Global Ocean Observing System
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-Based Activities
HABs	Harmful Algal Blooms
HEED	Health, Ecological and Economic Dimensions
ICAM	Integrated Coastal Area Management
ICM	Integrated Coastal Management
ICES	International Council for the Exploration of the Sea
ICOM	Integrated Coastal and Ocean Management
ICZM	Integrated Coastal Zone Management
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IUCN	World Conservation Union
JPOI	Johannesburg Plan of Implementation
NAICS	North American Industry Classification System
NGO	Non-governmental Organization
NMFS	National Marine Fisheries Service (United States Government)
NOAA	National Ocean and Atmospheric Administration (United States Government)
OECD	Organisation for Economic Co-operation and Development
OSPAR	Convention for the Protection of the Marine Environment of the North-East Atlantic
PAP/RAC	Regional Activity Centre for Priority Actions Programme (Mediterranean Action Plan)
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
POPs	Persistent Organic Pollutants
PSR	Pressure-State-Response
RAC/CP	Regional Activity Centre for Cleaner Production (Mediterranean Action Plan)
SEA	Strategic Environmental Assessment
SIDS	Small Island Developing States
UN	United Nations
UNCED	United Nations Conference on Environment and Development
UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNIDO	United Nations Industrial Development Organization
WHC	World Heritage Centre (of UNESCO)
WHO	World Health Organization
WSSD	World Summit on Sustainable Development

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-à-vis mandated roles and/or plans.

Assessment
A process (which may or may not be systematic) of gathering information, analysing it, and then making a judgment on the basis of that information.

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

Coastal population
Numbers and locations of people in coastal towns, cities and agricultural areas.

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.

Driving forces-Pressures-States-Impacts-Responses (DPSIR)
The causal framework for describing the interactions between society and the environment adopted by the European Environment Agency (extension of the PSR model developed by OECD).

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

Ecosystem approach
The ecosystem approach is a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way. It is based on the application of appropriate scientific methodologies focused on levels of biological organization that encompass the essential processes, functions and interactions among organisms and their environment. It recognizes that humans, with their cultural diversity, are an integral component of ecosystems.

Effectiveness
The improvement in the quality of life of coastal communities while maintaining the biological diversity and productivity of the ecosystem through an ICM programme.

Effects
Intended or unintended changes resulting directly or indirectly from a development intervention.

Efficiency
A measure of how economic 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 provides lessons 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 organization'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 programme is addressing and solving the issue(s) that led to the creation of the programme.

Impacts
Intended or unintended changes in environmental, social and economic conditions as a result of management actions or external pressures.

Impact indicators
Indicators that describe intended or unintended changes in environmental, social and economic conditions as an effect of management actions.

Indicator
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.

Integrated coastal and ocean management (ICOM)
A dynamic, multidisciplinary, iterative and participatory process to promote sustainable management of coastal and ocean areas balancing environmental, economic, social, cultural and recreational objectives over the long-term. ICOM entails the integration of all relevant policy areas, sectors, and levels of administration. It means integration of the terrestrial and marine components of the target territory, in both time and space.

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.

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.

Outcome evaluation
Evaluations that aim at assessing the impacts of developmental and environmental management efforts in environmental, physical and socio-economic 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 realize its purpose. These may also include changes, resulting from the intervention, which 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 (PSR)
A typical analysis of causes and effects, driving forces, and responses. It is part framework 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 summarized in numerical form, such as minutes from community meetings and general notes from observations. Qualitative data normally describe people's knowledge, attitudes or behaviors.

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.

Annexes

G1 Coordinating mechanism

Nature of indicator

Definition

The existence and functioning of a representative coordinating or management body that involves key government agencies involved in ICOM.

Unit of measurement

Qualitative assessment of the following dimensions:

- Is there a coordinating body for ICOM and with what mandate?
- Is the coordinating body representative and to what extent?
- Is the coordinating body functional and to what extent?
- Is the coordinating body effective and to what extent?
- Is the coordinating body sustainable and to what extent?

Relevance

Purpose

A representative and fully functional coordinating body is an essential feature of ICOM. The existence and functioning of such a body reflect the interest, at all levels, in ensuring the coordination of the different actors influencing coastal and marine areas and resources, as well as ensuring the representation of the interests of relevant stakeholders. A high-level policy planning body may be charged with the preparation of ICOM management policies, plans and programmes.

International conventions, agreements and targets

Agenda 21 recommends the establishment of coordinating mechanisms for integrated management and sustainable development of coastal and marine areas and their resources, at both the local and national levels. The WSSD Johannesburg Plan of Implementation (JPOI) further recommends coastal States to develop mechanisms for integrated coastal management. There are no internationally established targets and standards for this indicator.

Methodological description

Underlying definitions and concepts

A coordinating body for ICOM may be characterized by the following features:

- Involves a high political level;
- Is representative of both governmental and sectoral interests;
- Has a defined mandate and authority;
- Addresses in a comprehensive way the integrated management and sustainable development of coastal and marine areas and their resources;
- Involves consultation with different administrative levels and the most relevant stakeholders;
- Operates in a transparent way and is accountable for its decisions;
- Ensures regular and transparent communication and information exchange;
- Is influential on policies and programmes affecting coastal and marine resources;
- Results in operational decisions concerning the sustainable development of coastal and marine resources.

G1 Coordinating mechanism

Methodological description

Measurement approaches

There are two levels of measurement: One refers to the existence of an ICOM coordinating body, the other to its degree of representation, functionality, effectiveness and sustainability. The existence of an ICOM coordinating body can be monitored by examining relevant official documents (legislation and/or management plan) establishing the ICOM programme or project and the related organizational chart. The legal and formal mandate and authority can be understood from statutes, plans or other documents, which would also allow identification of the parties represented. Frequency of meetings, their attendance and the resulting decisions can be monitored by examining official meeting records. The influence of the formal acts of the coordinating body – recommendations or decisions – on sectoral policies and their coordination could be measured indirectly through other indicators (institutional, environmental or socioeconomic indicators), provided that adequate time series of data on outcomes are available. The sustainability of the coordinating body can be assessed by examining its activities over time. In most cases, the measurement will involve the examination of documents, as well as interviews with key informants.

Limitations of the indicator

There are no agreed international definitions or standards regarding what constitute a coordinating body for ICOM, except in general terms as set out in Agenda 21 and follow-up agreements. The indicator has a largely qualitative character and further work is required to develop criteria to assess its level of representation, functionality, effectiveness, accountability and sustainability.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

Agenda 21 and the JPOI refer to coordination mechanisms rather than coordinating bodies. Such coordinating mechanisms can take the form of high-level policy planning bodies, councils for strategic planning and management or interagency commissions with advisory role, and can be permanent or temporary. There is ample variety in the form and functions of coordinating bodies and mechanisms that reflects the specificities of political and administrative systems and types of interventions.

Assessment of data

Data needed to compile the indicator

ICOM plan, document of incorporation of a coordinating mechanism, composition of the coordinating body, dates and locations of meetings of the coordinating body, records of meetings.

Data sources and collection methods

The data will be available in government records. Document reviews, interviews and surveys may be added to gain further insights.

Analysis and interpretation of data

Description and qualitative assessment of the mandate and composition of the coordinating body, its operation, influence on sectoral policies, accountability and sustainability.

Reporting scale and output

The indicator may be monitored at all scales. The outputs may consist of a list and a narrative description of the coordinating body as above. When measured at the sub-national level, a map may be added showing the sub-national administrative units where institutional coordination is occurring.

G1 Coordinating mechanism

Additional information

Organizations and programmes involved in the development of the indicator

The United Nations Department of Social and Economic Affairs (UNDESA), Commission for Sustainable Development (CSD) is the UN agency most involved in the coordination of ocean and coastal issues.

References

Boelaert-Suominen, S. and Cullinan, C. (1994). *Legal and Institutional Aspects of Integrated Coastal Area Management in National Legislation*. FAO, Rome.

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

FAO (1998). *Integrated Coastal Management and Agriculture, Forestry and Fisheries*. FAO, Rome.

Sorensen, J.C. and McCreary, S.T. (1990). *Institutional Arrangements for Managing Coastal Resources and Environments*. 2nd ed. Renewable Resources Information Series, Coastal Management Publication 1. National Park Service/US Dept of Interior and US-AID, Washington, D.C.

Internet links

IOC. Marine Sciences and Observations for Integrated Coastal Area Management. IOC. http://ioc.unesco.org/icam/ (19/07/2006).
UN. Governance, ICAM. Atlas of the Oceans. http://www.oceansatlas.org/servlet/CDSServlet?status=ND0xMjc2MiY3PWVuJjYxPSomNjU9a29z (19/07/2006).
UN/DESA. Oceans and Seas. Sustainable Development Issues. http://www.un.org/esa/sustdev/sdissues/ocean/ocean.htm (19/07/2006)

G2 Legislation

Nature of indicator

Definition
The existence and adequacy of legislation for ICOM.

Unit of measurement
The existence and adequacy of legislation enabling the implementation of ICOM interventions. Several dimensions are measured:

Generic provisions:
- Existence of specific law(s) dealing with coastal and ocean areas;
- Legal endorsement of sustainable development and ICOM-related principles;
- Definition of coastal zone;
- Demarcation of coastal zone;
- Definition of the functions of the administrative actors dealing with coastal zones, including the role of a lead agency;
- Institutional cooperation and coordination;
- Information on coastal zones.

More detailed provisions:
- Land ownership;
- Beach access;
- Coastal land use planning;
- Control of industrial and commercial activities on the coast;
- Control of recreational activities;
- Protection of areas of ecological and natural value;
- Pollution;
- Coastal erosion and soil protection;
- Coastal hazards;
- Public information and participation;
- Monitoring and sanctions;
- Awareness and understanding of legislative controls;
- Effectiveness of regulatory system.

The indicator may be measured at the national, regional and local scales, taking into account the authority and functions of the different administrative levels.

Relevance

Purpose
The existence and adequacy of legislation is significant to describe the extent to which the goals and objectives of ICOM are supported by a clear and enforceable legal basis and the extent to which this enables the implementation of ICOM activities and interventions. ICOM legislation defines what is required, permitted and forbidden by stakeholders and administrative actors in the coastal and marine area. Awareness and understanding of ICOM legislation by stakeholders promotes compliance and therefore the achievement of ICOM goals and objectives.

International conventions, agreements and targets
While not specifically recommended by international agreements, the existence and adequacy of legal frameworks for ICOM underlies the implementation of all international conventions and agreements dealing with the subject. There are no internationally established targets and standards for this indicator.

G2 Legislation

Methodological description

Underlying definitions and concepts

Legislation for ICOM may be characterized by the following features:

- Incorporates principles related to sustainable development and specifically to oceans and coasts;
- Supports ICOM goals and objectives;
- Sets out processes for institutional cooperation and coordination;
- Lays out ICOM management activities and interventions.

Measurement approaches

Determine the existence of legislation on coastal and marine areas; this can be a law specific to coastal and marine areas or general texts whose provisions are applicable to coastal and marine areas. Determine whether the legislation — specific or not — incorporates sustainable development principles, provides a legal definition of coastal and marine areas and elements for the demarcation of coastal and marine areas at the local level and whether this definition is adequate to pursue ICOM. Determine whether the legislation clarifies the authority and functions of administrative actors in coastal and marine areas, includes provisions on land ownership, permitted and prohibited activities in the coastal zone and protection of natural heritage. Determine whether the legislation provides for public information and participation, monitoring of the conditions of the coastal zones, including through the use of indicators and monitoring of its applications and sanctioning for non-compliance. Determine whether the provisions of the legislation are understood and followed by the stakeholders.

Limitations of the indicator

The content of legislation for ICOM can significantly vary among countries, as well as within countries when sub-national authorities have authority over the coastal zone. Provisions of the legislation can be of a general or more detailed character, resulting in a variety of legal instruments. Even in the absence of specific legislation for ICOM, general or sectoral legislation can support ICOM goals and objectives. However, the existence of ICOM legislation does not necessarily imply effective implementation and compliance. The indicator may not be suitable to express meaningful trends and is open to subjective interpretation.

Status of the methodology

There is no internationally agreed methodology for measuring the indicator.

Alternative definitions/indicators

While certain countries have adopted a statutory approach to ICOM, others rely on a non-statutory approach. Few countries have developed framework or organic legislation for ICOM or coastal codes. Often legislation applicable to the coastal zones is embodied in general texts dealing with the environment, protected areas and nature conservation, water, or town and country planning. In addition, texts specific to the coastal zone actually address its marine component, as in the case of legislation on the public maritime domain, fishing, coastal defences, ports and navigation, offshore oil and gas and maritime jurisdictions.

G2 Legislation

Assessment of data

Data needed to compile the indicator
Legal documents or pertinent laws at different levels.

Data sources and collection methods
The data will be available in government records. Document reviews, interviews and surveys may be added to gain further insights.

Analysis and interpretation of results
A narrative report focusing on the coverage of ICOM goals and objectives by legislation, the degree of consistency of general and sectoral legislation, the clarification of the functions of administrative actors, the degree of support to ICOM activities and interventions, the degree of compliance. The output may consist of a report on the existing legislation on ICOM and its adequacy.

Reporting scale and output
The indicator may be monitored at all scales. When measured on a sub-national level, a map may be added showing the sub-national administrative units legislation that is enabling or hindering ICOM.

Additional information

Organizations and programmes involved in the development of the indicator
Organization for Economic Co-operation and Development (OECD); Priority Actions Programme/Regional Activity Centre (PAP/RAC), Mediterranean.

References
Boelaert-Suominen, S. and Cullinan, C. (1994). *Legal and Institutional Aspects of Integrated Coastal Area Management in National Legislation*. FAO, Rome.
Gibson, J. (1999). *Legal and Regulatory Bodies: Appropriateness to Integrated Coastal Zone Management*--Final Report. 1999. http://europa.eu.int/comm/dg11/iczm/themanal.htm.
OECD (1997). *Integrated Coastal Zone Management: Review of Progress in Selected OECD Countries*. OCDE/GD (97)83. OECD, Paris.
Prieur, M. and Ghezali, M. (2000). *National Legislations and Proposals for the Guidelines Relating to Integrated Planning and Management of the Mediterranean Coastal Zones*. PAP/RAC, Split.

Internet links
FAO, IUCN and UNEP. ECOLEX: A Gateway to Environmental Law. http://www.ecolex.org (19/07/2006).
CIESIN. ENTRI - Environmental Treaties and Resource Indicators. SEDAC – Socioeconomic Data and Application Center. http://sedac.ciesin.columbia.edu/entri/index.jsp (19/07/2006).
FAO. FAOLEX. http://faolex.fao.org/faolex/ (19/07/2006).

G3 Environmental assessment

Nature of indicator

Definition

The mandatory assessment of the potential effects on the coastal and marine environment of sectoral policies, plans, programmes and projects occurring in the coastal area and adjacent watersheds and offshore areas.

Unit of measurement

Qualitative and quantitative assessment of the following dimensions:

- Existence of statutory procedures for environmental impact assessment (EIA) for projects relevant to coastal and marine areas;
- Existence of statutory procedures for strategic environmental assessment (SEA) for policies, plans and programmes relevant to coastal and marine areas;
- Existence and procedures for carrying capacity assessment (CCA);
- Application of EIA procedures;
- Application of SEA procedures;
- Application of CCA procedures;
- The level to which EIA, SEA and CCA procedures enable and support ICOM efforts.

Relevance

Purpose

The objective of the indicator is to measure whether the ICOM process is enabled and supported by a process of EIA carried out both at the strategic level of sectoral plans and programmes and of individual projects, including for cumulative impacts and its effectiveness in supporting sustainable development goals. This process is also particularly relevant to ICOM in that it is based on public consultations and promotes participation and transparency of decision-making.

International conventions, agreements and targets

Prior assessment and systematic observation of major projects is recommended by Agenda 21 as an application of preventive and precautionary approaches. The identification and assessment of problems, as well as the establishment of priorities, including the application of EIA procedures are an important component for the implementation of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA). The use of EIA procedures is also recommended by the Barbados Programme of Action (BPOA) for Sustainable Development of Small Island Developing States (SIDS) to improve management of land resources. In the context of building capacity in marine science, information and management, the JPOI promotes the use of environmental impact assessments and environmental evaluation and reporting techniques. The Aarhus Convention on Access to Information, Public Participation in Decision-Making and Access to Justice in Environmental Matters (Aarhus Convention) also recommends the use of EIA procedures and public consultations.

G3 Environmental assessment

Methodological description

Underlying definitions and concepts

EIA can be defined as the prior assessment of public and private projects likely to have significant effects on the environment—encompassing human beings, fauna, flora, soil, water, air, climate, landscape, material heritage, cultural heritage and the interactions among them. Potential environmental consequences of projects are identified and assessed before authorization is given, public opinion is sought and taken into account in decision-making and final decisions are made public.

In the case of SEA, environmental assessment applies to plans and programmes and even policies. These may be in the sectors of agriculture, forestry, fisheries, energy, industry, transport, waste management, water management, telecommunications, tourism, town and country planning or land use. SEA enables a more strategic and long-term planning than EIA and further promotes the involvement of the public in the decision-making process and the incorporation of environmental consideration into development actions. SEA can provide a framework for the coordination of sectoral policies, thus enabling an integrated approach.

CCA has typically been used in relation to the planning process for tourism development in coastal or island areas, as well as in protected areas to set capacity limits for sustaining tourism in a particular place through the measurement of tourism density, the use of beaches and tourist infrastructure, congestion of facilities and transportation infrastructure, demand and impact on water and energy resources, marine pollution, etc.

Measurement approaches

The measurement of this indicator may be based on the following dimensions, which are similar for EIA and SEA:

- The existence of legally established procedures for EIA or SEA and the types of interventions subject to environmental impact review;
- The interventions relevant to the coastal and marine environment actually subjected to review, the level of public consultation involved and the final decision made;
- The interventions required to undertake modifications and monitoring of the follow-up;
- The estimated environmental and socioeconomic benefits achieved through the modifications or cancelling of the interventions following the environmental review;
- The impact on the coordination of sectoral policies.

In the case of CCA, a similar approach may be adopted, focusing on the modifications induced in the tourism development initiative following the application of the CCA and the on the estimate of the environmental and socioeconomic benefits.

Limitations of the indicator

The indicator is of a broad nature and involves a number of dimensions that need to be qualitatively and quantitatively assessed. With the availability of adequate documentation it is relatively easy to ascertain which interventions have been subjected to environmental review. In contrast, the quantification of the environmental and socioeconomic benefits accrued to the coastal and marine areas of concern might require a significant effort.

Status of the methodology

Methodologies for EIA, SEA and CCA are well developed and may be adapted to the specific contexts of coastal and marine areas.

Alternative definitions

—

G3 Environmental assessment

Assessment of data

Data needed to compile the indicator
Legislation and regulations, EIA studies, opinions of competent authorities.

Data sources and collection methods
The data for EIA and SEA will be available primarily at government authorities, and can be collected through document reviews, databases, interviews and surveys.

Analysis and interpretation of results
The analysis of the data should focus on the environmental, socioeconomic and governance outcomes of the EIA, SEA and CCA processes.

Reporting scale and output
The indicator is best monitored at the sub-national scale. Data should be presented in tables and the location of the interventions shown on a map.

Additional information

Organizations and programmes involved in the development of the indicator
Both the EC and the World Bank are currently involved in the development of methodologies for SEA.

References
Dragicevic, M., Klaric, Z. and Kusen, E. (1997). *Guidelines for Carrying Capacity Assessment for Tourism in Mediterranean Coastal Areas*. PAP-9/1997/G.1. PAP/RAC, Split.
EC (1999). *Guidelines for the Assessment of Indirect and Cumulative Impacts as well as Impact Interactions*. E.C., Brussels.
EC (2001). *SEA and Integration of the Environment into Strategic Decision-Making*. ICON, London.
UNEP (1990). *An Approach to Environmental Impact Assessment for Projects Affecting the Coastal and Marine Environment*. UNEP Regional Seas Reports and Studies 122. UNEP, Nairobi.

Internet links
World Bank. Strategic Environmental Assessment. Environment. http://lnweb18.worldbank.org/ESSD/envext.nsf/41ByDocName/AnalyticalandAdvisory-AssistanceStrategicEnvironmentalAssessment (19/07/2006).

G4 Conflict resolution mechanism

Nature of indicator

Definition

The existence and functioning of a mechanism for the resolution of conflicts in the coastal zone.

Unit of measurement

Qualitative and quantitative assessment of the following dimensions:

- Stakeholders and issues at stake involved in conflicts, nature and intensity of conflicts;
- Existence of agreed procedures and mechanisms for the resolution of conflicts over coastal resources;
- Changes in the proportion of conflicts that are successful mitigated, resolved, or prevented;
- Overall changes in the number of conflicts over coastal resources.

Relevance

Purpose

By its nature, the coastal area is characterized by conflicts due to limited natural resources and competing interests over scarce space and resources. The existence and functioning of procedures and mechanisms for the resolution of conflicts over coastal resources and the actual reduction of conflicts — be they prevented, mitigated, or resolved — reflects the ability of an ICOM initiative to strike a satisfactory balance between competing interests in the coastal zone. One of the roles of ICOM is to provide a framework to reconcile such competing interests and conflicts at all levels — institutional, social, economic — and all spatial scales — local, regional, national. Therefore, the indicator is highly relevant to ICOM and coastal sustainable development.

International conventions, agreements and targets

Attention to user conflicts has been called for by Agenda 21, in relation to coordinating mechanisms for integrated management and sustainable development of coastal and marine areas and their resources, and the FAO Code of Conduct for Responsible Fishing. There are no internationally established targets and standards for this indicator.

G4 Conflict resolution mechanism

Methodological description

Underlying definitions and concepts

A mechanism for conflict resolution may be characterized by the following features:

- Provides for dispute resolution procedures alternative to litigation;
- Ensures representation of all interests;
- Ensures the enforceability of the agreement reached;
- Limits power imbalances between parties;
- Provides for funding mechanisms for conflict resolution as part of an ICOM initiative;
- Gives consideration to the involvement of third parties.

Conflict resolution may also be ensured through procedures for negotiated rule-making, incentive and compensation. The perception of a successful resolution of a conflict may vary depending on the party. However, in general terms, a criterion is the acceptance by all parties that the solution has been achieved according to agreed rules.

Measurement approaches

There are three levels of measurement: the first level refers to the stakeholders involved in conflicts and the issues at stake; the second refers to the existence and characteristics of a coordinating mechanism for ICOM; the third refers to the number and types of conflicts over coastal resources and their changes.

Firstly, it is necessary to identify the conflicts over the use of coastal resources, which stakeholders are involved in conflicts and what are the issues at stake. Then it is necessary to understand the characteristics of the conflicts: their geographical and temporal scale, the intensity, whether the conflicts have been resolved and by whom and with which outcome and degree of agreement. Secondly, it is necessary to identify the procedure or mechanism for the resolution of conflicts and its characteristics. Thirdly, it is necessary to determine the proportion of conflicts that are successfully resolved, mitigated or prevented through the use of such mechanism, as well as the changes in the overall number of conflicts over coastal resources.

Limitations of the indicator

The change in the number of conflicts that are successfully resolved and the reduction in the number of conflicts over coastal and marine resources reflect, in general terms, the ability of an ICOM initiative, although the perception of a successful resolution may vary according to the parties' views.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

—

G4 Conflict resolution mechanism

Assessment of data

Data needed to compile the indicator

Project and government agency records, community management records, records from conflict resolution meetings, results from interviews and from participatory rural assessments.

Data sources and collection methods

Government agencies, stakeholders. Review of records and documents, interviews, participatory rural assessments.

Analysis and interpretation of results

Assessment of individual conflicts can be done through the use of matrices of conflicts showing issues at stake, stakeholders involved, time period, scale, intensity, whether conflicts are ongoing/managed/resolved, and how they are managed/resolved. The functioning of the mechanism for conflict resolution can be assessed based on the criteria presented above. Changes in the level of conflicts can be analysed by stakeholder and issue at stake, assessing whether certain types of conflicts are less tractable than other.

Reporting scale and output

The indicator needs to be monitored at the level of individual coastal areas and ICOM initiatives. The output may consist of a narrative report with analysis matrices and maps.

Additional information

Organizations and programmes involved in the development of the indicator

—

References

FAO (1998). *Integrated Coastal Management and Agriculture, Forestry and Fisheries*. FAO, Rome.

Goldberg, E.D. (1994). *Coastal Zone Space: Prelude to Conflict?* UNESCO, Paris.

Rijsberman, F. (Ed.) (1999). *Conflict management and consensus building for integrated coastal management in Latin America and the Caribbean*. Technical Report ENV-132. Inter-American Development Bank, Washington, D.C.

UNESCO (2002). *Managing conflicts over resources and values: Continental coasts. Results of a workshop on 'Wise practices for coastal conflict prevention and resolution'*, Maputo, Mozambique, 19–23 November 2001. Coastal region and small island papers 12. UNESCO, Paris.

UNESCO (2002). *Wise practices for conflict prevention and resolution in small islands. Results of a workshop on 'Furthering coastal stewardship in small islands', Dominica*, 4–6 July 2001. Coastal Region and Small Island Papers 11. UNESCO, Paris.

Internet links

—

G5 Integrated management plans

Nature of indicator

Definition

The existence and adoption of an ICOM plan that details goals and objectives, the institutional arrangements involved, the management measures to be undertaken, as well as the legislative and financial support for implementation.

Unit of measurement

Qualitative assessment of the following dimensions:

- Existence of the plan;
- Status of the plan;
- Completeness of the plan;
- Enforceability of the plan.

The indicator may be measured at all scales.

Relevance

Purpose

The existence and adoption of an ICOM plan reflects the commitment of the relevant agency or agencies to manage coastal and marine areas in an integrated, cross-sectoral and multidisciplinary way. The ICOM plan sets out the strategic directions, goals and objectives for the coastal zone covered by the plan and details the institutional structure, measures, activities, as well as the legislative and financial means for their achievement.

International conventions, agreements and standards

Agenda 21 calls for coordinating mechanisms and high-level policy planning bodies for the implementation of integrated coastal and marine management and sustainable development plans and programmes at appropriate levels, as well as a number of other measures. The JPOI has further called for the promotion of integrated, multidisciplinary and multisectoral coastal and ocean management at the national level as well as for the assistance to developing countries for the implementation of integrated coastal area management plans as a tool for the conservation and sustainable management of fishery resources. The development of national strategies and actions plans for coastal zone management or related sectors has also been called for by the BPOA, the GPA and the FAO Code of Conduct. There are no internationally established targets and standards for this indicator.

G5 Integrated management plans

Methodological description

Underlying definitions and concepts

An ICOM plan may be characterized by the following features:

- Outlines a vision and the strategic directions for the coastal area subject to the plan;
- Incorporates sustainable development principles and principles related to the special nature of oceans and coasts;
- Defines goals and objectives;
- Defines specific activities to achieve the goals and objectives;
- Details a management strategy and administration;
- Includes provisions for surveillance and enforcement;
- Includes provisions on monitoring, evaluation and adjustment.

Measurement approaches

Qualitative assessment of two main aspects: (a) the existence and status of the plan and (b) the completeness and enforceability of the plan. Firstly, the existence of the plan in a printed form should be ascertained and its status — formulation, approval, adoption and signatories, level of implementation and review and update — assessed. Secondly, the plan should be examined in relation to its content (underlying principles, scope, area of application, goals and objectives, management strategy, administrative structure, surveillance and enforcement, monitoring and evaluation, etc.). Thirdly, the enforceability of the plan should be assessed by examining the legal and administrative basis of the management measures.

Limitations of the indicator

There are no internationally agreed definitions or standards for ICOM plans and for the measures that an ICOM plan may entail. The indicator is of a qualitative nature and interpretation of its adequacy may be subjective. Criteria concerning the effectiveness of an ICOM plan also need to be developed.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

In some cases, goals and objectives might have been expressed informally and agreed upon by interested parties or be embodied in environmental or sectoral development plans. ICOM may be a part of strategies and plans encompassing a larger geographical area, such as a watershed or including the entire national or regional/provincial territory.

G5 Integrated management plans

Assessment of data

Data needed to compile the indicator
ICOM management plan.

Data sources and collection methods
Document review of the official gazette and of government records, accompanied by interviews with key informants.

Analysis and interpretation of results
Description and qualitative assessment of the existence, status, contents and enforceability of the ICOM plan.

Reporting scale and output
The indicator may be reported at all scales through a narrative report and maps.

Additional information

Organizations and programmes involved in the development of the indicator
—

References
Bower, B., Ehler, C.V. and Basta, D. (1994). *A Framework for Planning for Integrated Coastal Zone Management*. NOAA, Silver Spring, Maryland.
Clark, J.R. (1995). *Coastal Zone Management Handbook*. Lewis Publishers, Boca Raton, Florida.
Kay, R. and Adler, J. (1999). *Coastal Planning and Management*. Routledge, New York.
Salm, R.V. and Clark, T. (1984). *Marine and Coastal Protected Area: A Guide for Planners and Managers*. IUCN, Gland.
Sorensen, J.C. and McCreary, E. (1990). *Institutional Arrangements for Managing Coastal Resources and Environment*. Coastal Management Publication 1. National Park Service, U.S. Department of Interior, Washington, D.C.

Internet links
UN. Governance, ICAM. Atlas of the Oceans. http://www.oceansatlas.org/servlet/CDSServlet?status=ND0xMjc2MiY3PWVuJjYxPSomNjU9a29z (19/07/2006).

G6 Active management

Nature of indicator

Definition

The level of implementation, compliance with, as well as enforcement of ICOM plans and related activities.

Unit of measurement

Qualitative and quantitative measures of:

- Level of implementation of ICOM plans and related activities;
- Use of procedures and legal tools for the implementation and enforcement of ICOM plans and activities;
- Level of enforcement of ICOM plans and activities;
- Level of compliance with ICOM-related provisions.

Relevance

Purpose

The level of implementation, compliance with and enforcement of ICOM plans and activities reflects the reality of the execution and performance of ICOM initiatives, as well as the degree of acceptance on the part of the users subject to the plan. The implementation, compliance with and enforcement of ICOM strategies and plans for the integrated development and use of land and sea space and their mandatory character for national and/or local authorities, as well as private individuals, concerning conditions for land use and other activities and projects is the direct and practical translation of the ICOM vision, principles, goals and objectives. This represents an essential contribution to the sustainable development of coastal and marine areas.

International conventions, agreements and targets

For references to international conventions and agreements see indicator 3.3, ICOM Plan. There are no internationally established targets and standards for this indicator.

G6 Active management

Methodological description

Underlying definitions and concepts

The implementation of ICOM strategies, plans, programmes and activities, as well as their enforcement and compliance, may be characterized by the following features:

- Performance of the ICOM strategies, plans, programmes and activities in relation to the relevance to the stated objectives;
- Implementation of policy measures (e.g., planning, institutional strengthening, regulatory and economic instruments, or environmental education);
- Monitoring of compliance with ICOM provisions;
- Compliance with ICOM provisions;
- Existence and use of enforcement procedures.

Measurement approaches

Qualitative and quantitative assessment of several dimensions:

- The relevance of the ICOM initiative to the needs it addresses and objectives it pursues;
- The level, quantity and quality of implementation and related outputs and activities of the ICOM initiative and progress towards the realization of outcomes and activities;
- The effectiveness of implementation in terms of the timeliness and cost-effectiveness of the intervention;
- The efficiency of implementation in terms of availability of funds and human resources, managerial and work efficiency, as well as implementation difficulties;
- The degree of intergovernmental and intersectoral integration achieved by the initiative;
- The degree of compliance of the users with the initiative;
- The measures put in place to enforce the initiative;
- The prospect for sustainability of the initiative.

The methodologies available for measuring this indicator and its dimensions generally fall within the scope of performance evaluation.

Limitations of the indicators

To be fully useful the indicator has to be linked to the environmental and socioeconomic indicators for an assessment of outcomes and impacts. This entails the combination of performance evaluation methodologies with a robust series of baseline data on the phenomena the ICOM initiative intends to address.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

Alternative definitions for this indicator can be found in relation to the performance evaluation of ICOM interventions and environmental compliance and enforcement.

G6 Active management

Assessment of data

Data needed to compile the indicator
ICOM management plan, management records, evaluation reports.

Data sources and collection methods
Document reviews of the official gazette, records from government offices and multilateral and bilateral donors as well as independent evaluations, to be complemented by interviews and surveys.

Analysis and interpretation of results
Description and quantitative and qualitative assessment of the implementation, compliance with, and enforcement of the ICOM initiative.

Reporting scale and output
The indicator can be measured at all scales. The output may consist of a narrative report on the implementation, compliance with, and enforcement of ICOM strategies, plans, programmes and activities. Maps may also be included.

Additional information

Organizations and programmes involved in the development of the indicator
EUCC, Europe; PAP/RAC, Mediterranean; Partnerships in Environmental Management for the Seas of East Asia (PEMSEA), Southeast Asia.

References
Bower, B., Ehler, C.V. and Basta, D. (1994). *A Framework for Planning for Integrated Coastal Zone Management*. NOAA, Silver Spring, Maryland.
Clark, J.R. (1995). *Coastal Zone Management Handbook*. Lewis Publishers, Boca Raton, Florida, 1995.
Kay, R. and Adler, J. *Coastal Planning and Management*. Routledge, New York.
Salm, R.V. and Clark, T. (1984). *Marine and Coastal Protected Area: A Guide for Planners and Managers*. IUCN, Gland.
Sorensen, J.C. and McCreary, E. (1990). *Institutional Arrangements for Managing Coastal Resources and Environment*. Coastal Management Publication 1. National Park service, U.S. Department of Interior, Washington, D.C.

Internet links
EUCC. The Coastal Guide. http://www.coastalguide.org (8/08/06).
PAP/RAC. Mediterranean ICAM Clearing House. http://www.pap-medclearinghouse.org/ (8/08/06).

G7 Monitoring and evaluation

Nature of indicator

Definition

The routine monitoring and evaluation of ICOM initiatives and activities and, where needed, the subsequent adjustment of the programme or project.

Unit of measurement

Quantitative and qualitative measurement of the following dimensions:

- The existence, coverage (issues, baseline data, spatial, temporal), nature (self-assessment vs. independent evaluation) and quality of an operational monitoring and evaluation system, including indicators, for the ICOM initiative;
- The degree of involvement of stakeholders in the monitoring and evaluation process;
- The delivery of results from the monitoring and evaluation system and their consideration by the ICOM managers;
- The adjustments made to the ICOM initiative as a result of the information provided by the indicators;
- The transparency of the monitoring and evaluation process and the dissemination of the results to a wide audience, including through state of the coast reports.

Relevance

Purpose

An operational monitoring and evaluation system is vital to the continuous assessment of the progress of ICOM initiatives and their effectiveness. While this handbook is in itself a contribution to the development of a monitoring and evaluation system, most ICOM initiatives incorporate such system; this indicator is included to measure some specific dimensions of the monitoring and evaluation system that reflect its quality and usefulness. The use of monitoring and evaluation systems and indicators is directly relevant to ICOM and sustainable development in that it can help determine whether ICOM initiatives are meeting their stated objectives and generating the intended impacts, as well adapting to changing conditions.

International conventions, agreements and targets

Monitoring and evaluation in a general sense, and more specifically for ICOM, has been recommended by a number of international agreements. The United Nations Convention on the Law of the Sea (UNCLOS) refers to the monitoring of the risks of pollution, while Agenda 21 recommends the development of environmental criteria, socioeconomic indicators and environmental assessment as well as the building of capacity of developing countries in the area of data and information. Agenda 21 also recommends the development of sustainable development indicators (chapter 40, passim). Monitoring of components of biological diversity is provided for by the Convention on Biological Diversity (CBD), while the BPOA calls for comprehensive monitoring programmes for coastal and marine resources, support to SIDS for surveillance and monitoring of activities in the exclusive economic zones, monitoring and assessment for decision making on water management and hazards. The GPA recommends the identification and evaluation of problems and the development of criteria to determine whether programmes are meeting their objectives. The FAO Code of Conduct suggests elements for the monitoring and control of fishing activities and aquaculture, as well as monitoring of the coastal area as part of coastal area management and multidisciplinary research on coastal area management and fish stock assessment and impacts from habitat alteration and ecosystem changes. The JPOI also recommends further work on sustainable development indicators. There are no internationally established targets and standards for this indicator.

G7 Monitoring and evaluation

Methodological description

Underlying definitions and concepts

A monitoring and evaluation system for ICOM may be characterized by the following features:

- Coverage of environmental, socioeconomic and governance issues directly relevant to ICOM;
- Availability of baseline data on such issues with adequate spatial and temporal coverage and use of indicators;
- Adequate capacity and preparation (human resources, infrastructure, instrumentation) to operationalize the system;
- Meaningful involvement of relevant stakeholder in the design, implementation and use of the system;
- Transparency of the system, also through the combined use of internal and external evaluation;
- Routine use of the system and periodic delivery of results to decision-makers;
- Adaptation of the ICOM initiative based on the results provided by the monitoring and evaluation system;
- Dissemination of results from the monitoring, evaluation and adaptation process to a wide audience.

Measurement methods

Qualitative and quantitative assessment of the following dimensions:

- The existence of a monitoring and evaluation system for the ICOM initiative;
- The characteristics of the monitoring and evaluation system (relevance to the issues and objectives of the ICOM initiative, coverage, availability of baseline data, periodicity of measurements);
- The involvement of relevant stakeholders in the design and implementation of the system;
- The monitoring capability of the organization in charge (human resources, infrastructure, instrumentation, funding);
- The routine use of the system for monitoring the conditions of the coastal zone and the progress of the ICOM initiative;
- The delivery of policy-oriented information;
- The adjustments made to the ICOM initiative as a result of the information provided by the system;
- The dissemination of the information from the system to a wide audience.

Limitations of the indicators

Often monitoring and evaluation systems are designed and implemented at a late stage, and thus do not provide adequate information to assess the progress of an ICOM initiative and adopt the necessary adjustments. Moreover, often such systems focus on sectoral monitoring, losing a more comprehensive picture encompassing environmental, socioeconomic and governance issues. Evaluation also often focuses on management processes, with limited attention to outcomes and impacts.

Status of the methodology

There is currently no internationally agreed methodology for the indicator.

Alternative definitions

—

G7 Monitoring and evaluation

Assessment of data

Data needed to compile the indicator
Quantitative and qualitative results of review of plans, evaluations, state of the coast reports, budget, staffing, management systems, work programme and patrol reports.

Data sources and collection methods
ICOM plan, state of the coast reports, evaluation reports, budget, staffing, management systems, work programme and patrol reports. Review of documents, budget, staffing and management systems, annual work programme and patrol reports.

Analysis and interpretation of results
Description and qualitative and quantitative assessment of monitoring capacity, operability of the monitoring and evaluation system, stakeholder involvement and transparency of the monitoring and evaluation process, consistency of results of the process and the state of the coast, use of indicators, consideration of results in the decision-making process and adjustments to the ICOM initiative based on the results of the process.

Data collection methods
The indicator can be monitored at the level of the individual ICOM initiative, independently from its scale. The output may consist of a narrative report on the monitoring, evaluation and adjustment of the ICOM initiative.

Additional information

Organizations and programmes involved in the development of the indicator
EU (Europe); PEMSEA (Southeast Asia).

References
Belfiore, S., Balgos, M., McLean, B., Galofre, J., Blaydes, M. and Tesch, D. (2003). A Reference Guide on the Use of Indicators in Integrated Coastal Management. IOC, Paris.

CBD (2004). Integrated marine and coastal area management (IMCAM) approaches for implementing the Convention on Biological Diversity. CBD Technical Series 14. CBD, Montreal.

Chua, T.E., Jihyun, L., Yu, H., et al. (2003). Measuring the Performance of Integrated Coastal Management Programmes. Paper presented at the International Conference on the Sustainable Development of the Seas of East Asia: Towards a New Era of Regional Collaboration and Partnerships, 8-11 December 2003.

ETC/TE (2003). Measuring Sustainable Development of the Coast. A Report to the EU ICZM Expert Group by the Working Group on Indicators and Data under the lead of ETC-TE. ETC/TE, Barcelona.

Olsen, S., Lowry, K., et al. (1999). A Manual for Assessing Progress in Coastal Management. Coastal Management Report 2211. Coastal Resources Center, Narragansett, RI.

Olsen, S. (2003). Frameworks and indicators for assessing progress in integrated coastal management initiatives. Ocean and Coastal Management 46: 347-361.

Pickaver, A.H., Gilbert, C. and Breton, F. (2004). An indicator set to measure the progress in implementation of integrated coastal zone management in Europe. Ocean and Coastal Management 47: 449-462.

Pomeroy, R.S., Parks, J.E. and Watson, L.M. (2004). How is Your MPA Doing? IUCN, Gland.

Internet links
IOC, NOAA, DFO and CMP. The Role of Indicators in Integrated Coastal Management. http://www.udel.edu/CMS/csmp/indicators/index.html (19/07/2006).

G8 Human, technical and financial resources

Nature of indicator

Definition

The availability and allocation of administrative resources for ICOM as an expression of the capacity of the management team to administer and implement ICOM activities over time, based on the degree of access to and enabling human and financial resources, as well as facilities and equipment.

Unit of measurement

There are three dimensions to be measured in both quantitative and qualitative terms:

- The number, formation, experience and performance of staff devoted to ICOM;
- The budget allocated and available for ICOM activities and interventions;
- The facilities and equipment available for ICOM activities and interventions.

Relevance

Purpose

The operation of ICOM programmes and projects requires the timely availability of adequate administrative resources — staff, budget and equipment. The indicator reflects the appropriateness of the resources available to the management team to adequately carry out the required activities and interventions.

International conventions, agreements and targets

Agenda 21 details a number of requirements for the means of implementation for ICOM: financing and cost evaluation, scientific and technological means, human resources development and capacity building. There are no internationally established targets and standards for this indicator.

G8 Human, technical and financial resources

Methodological description

Underlying definitions and concepts

The indicator may be characterized by the following:

- An adequate number of formed/trained and performing staff is available to prepare, implement and follow up management activities and interventions;
- Adequate and sustained financial resources are allocated and readily available to support management activities and interventions;
- Adequate and regularly maintained facilities and equipment are available to carry out activities and interventions.

Measurement approaches

Firstly, ICOM activities and interventions must be identified and related needs in terms of staff (experience, education and performance) financial resources and facilities and equipment determined. Secondly, the budget allocated to ICOM and the availability and timeliness of release of funds must be determined. Thirdly, the quantity and quality of facilities and equipment (age, condition and maintenance) must be examined. When possible, data may also be expressed as proportion of the staff, budget, equipment and facilities available at the relevant agency or agencies (e.g., an Environmental or Land Use Planning Department).

Limitations of the indicator

The dimensions and sub-dimensions of the indicator need to be carefully isolated and measured. Staff levels, for example, need to be combined with required preparation and experience, on-the-job training completed, performance rating and turnover. Training completed, for example, is not a surrogate measure for preparation or performance. The budget allocated to ICOM needs to be calculated, above all, in relation to the highest priorities and a distinction must be made between normal budget allocations and project allocations. Availability of funding should be checked against their actual disbursement and sustainability over time. The indicator could show significant changes over time, but could be difficult to measure during project implementation because of the substitution of project funds for normal budget allocations. In addition, some ICOM functions might be shared among several agencies, making it difficult to isolate them from activities of a broader scope.

Status of the methodology

There is no internationally agreed methodology for measuring the indicator.

Alternative definitions

—

G8 Human, technical and financial resources

Assessment of data

Data needed to compile the indicator
Staff records, budget documents, management records and inventories.

Data sources and collection methods
Government records for document review, interviews and surveys.

Analysis and interpretation of results
Prepare a narrative report on the current availability and allocation of staff, budget and facilities and equipment to ICOM activities and interventions in relation to determined needs; provide recommendations.

Reporting scale and output
The indicator can be reported per administrative unit. The output may consist of a report on the current status of staffing, budget and facilities and equipment for ICOM.

Additional information

Organizations and programmes involved in the development of the indicator
—

References
—

Internet links
—

G9 Inputs from scientific research

Nature of indicator

Definition
The existence and application of scientific research in the ICOM process.

Unit of measurement
Qualitative assessment of four dimensions:
- The conduct of scientific research targeted or useful to ICOM;
- The production of scientific outputs from this research;
- The use of such outputs by ICOM managers;
- The existence of a scientific advisory committee for ICOM.

Relevance

Purpose
The existence and application of scientific research targeted or useful to ICOM reflect the relevance of scientific research to management purposes, its feedback into management and, ultimately, the improvement of management actions as a result of scientific knowledge. The indicator is not specific to ICOM in that it can be applied to many other sectors. However, the indicator is important in measuring the extent to which scientific research, targeted or not, is undertaken, generates knowledge relevant to ICOM and is actually incorporated into ICOM initiatives. Given the complexity of the coastal system, effective management cannot occur without a sound scientific basis.

International conventions, agreements and targets
The development of scientific research for ICOM and ICOM-related activities is crosscutting to many international conventions and agreements. Provisions related to scientific research for ICOM are contained, among others, in Agenda 21, UNCLOS, GPA and BPOA. There are no internationally established targets and standards for this indicator.

G9 Inputs from scientific research

Methodological description

Underlying definitions and concepts

The existence and application of scientific research and input may be characterized by the following features:

- Availability of scientific knowledge relevant to ICOM;
- Mechanisms to enhance the communication between scientists and managers;
- The scientific knowledge must be applicable and be used by ICOM managers.

Measurement approaches

Measurements are taken at different levels: the existence and coverage of scientific studies relevant to ICOM; detailed information may be collected on the content of such studies. In the case of completed studies, the outputs generated by them are measured. Another level concerns the use of the scientific outputs by ICOM managers, as well as the processes for the prioritization of scientific research targeted to ICOM and the mechanisms available for routine communication between scientists and managers.

Limitations of the indicator

A major limitation lies in the difficulty to isolate specific inputs from scientific research into ICOM initiatives and the large volume of scientific studies and literature that are relevant to ICOM.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

While not exactly an alternative definition, the indicator could also be calculated in terms of the investments made in scientific research considered relevant to ICOM, assuming that results and scientific knowledge generated from such research are generally used by ICOM managers.

G9 Inputs from scientific research

Assessment of data

Data needed to compile the indicator
Scientific studies and results, meeting records.

Data sources and collection methods
Government records, university and research centres records and databases, national academy of science reports on coastal and marine research. Document review, interviews.

Analysis and interpretation of results
Description and qualitative assessment of the lines of research relevant to ICOM, individual studies, the use of results and outputs for management and further research needs.

Reporting scale and output
The indicator may be monitored at different scales. The output may consist of a report on the contribution of scientific research to ICOM.

Additional information

Organizations and programmes involved in the development of the indicator
Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP);
Intergovernmental Oceanographic Commission (IOC); Global Ocean Observing System (GOOS).

References
GESAMP (1996). *The Contributions of Science to Coastal Zone Management*. GESAMP Reports and Studies 61. FAO, Rome.
GESAMP (2001a). *A Sea of Troubles. GESAMP Reports and Studies 70*. UNEP, London.
GESAMP (2001b). *Protecting the Oceans from Land-based Activities*. GESAMP Reports and Studies 71. UNEP, London.
GOOS (2003). *The Integrated Strategic Design for the Coastal Ocean Observations Module of the Global Ocean Observing System*. GOOS Report 125. UNESCO, Paris.

Internet links
GESAMP. GESAMP. http://gesamp.imo.org/ (19/07/2006).
GOOS. The Global Ocean Observing System. http://ioc.unesco.org/goos/ (19/07/2006).
IOC. Marine Sciences and Observations for Integrated Coastal Area Management. IOC, UNESCO, Paris. http://ioc.unesco.org/icam/ (19/07/2006).
UN. Ocean Issues. Atlas of the Oceans. http://www.oceansatlas.org/html/workissues.jsp (19/07/2006).

G10 Stakeholder participation

Nature of indicator

Definition

The level of participation of stakeholders in decision-making processes and activities related to ICOM and their level of satisfaction with ICOM mandates and outcomes.

Unit of measurement

Qualitative assessment of three main dimensions:

- Level of participation of stakeholders in decision-making processes and activities related to ICOM;
- Level of satisfaction of stakeholders with such participation;
- Level of satisfaction of stakeholders with ICOM outcomes (environmental quality, human health, economic opportunities).

Relevance

Purpose

The level of participation of stakeholders in ICOM decision-making processes and activities, as well as their satisfaction, reflect the amount of active involvement of users in ICOM and the consideration of their views and concerns by ICOM managers. Active participation and satisfaction of stakeholders can improve the success of ICOM initiatives by increasing the level of ownership and sustain support. Stakeholder participation is also a measure of the transparency and accountability of the ICOM decision-making process.

International conventions, agreements and targets

Agenda 21 recommended the establishment of coordinating mechanisms 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, NGOs, local communities, resource user groups and indigenous people. The involvement of stakeholders is also recommended in relation to the development of capacity building efforts. It is also recommended by many other coastal- and ocean-related conventions and agreements: e.g., UNCLOS, for public participation in environmental impact assessment procedures; BPOA for the participation of local communities in monitoring programmes for coastal and marine resources and the involvement of NGOs, women, indigenous people and other major groups, as well as fishing communities and farmers, in the conservation and sustainable use of biodiversity and biotechnology; GPA, for the involvement of stakeholders in integrated coastal management approaches, in particular local authorities and communities, as well as relevant social and economic sectors, including NGOs, women, indigenous people and other major groups; and the FAO Code of Conduct for the representation and consultation of the fisheries sector and fishing communities in the decision-making processes and other activities related to coastal area management planning and development. On environmental issues in general, the Aarhus Convention provides for the involvement of stakeholders in sustainable development processes, links government accountability and environmental protection through the interaction between public and public authorities and promotes a new process for public participation in the negotiation and implementation of international agreements. There are no internationally established targets and standards for this indicator.

G10 Stakeholder participation

Methodological description

Underlying definitions and concepts

Stakeholders participation in and satisfaction with ICOM decision-making processes and activities may be characterized by the following features:

- Through appropriate mechanisms, stakeholders are informed, consulted, and participate in decision-making processes and activities related to ICOM;
- Stakeholders are satisfied with their participation in ICOM decision-making processes and activities and perceive that their views and concerns are taken into account by ICOM decision makers and managers.

Measurement methods

There are two levels of quantitative and qualitative measurement: the first level refers to the level of participation of stakeholders in ICOM decision-making processes and activities; the second refers to the level of satisfaction of stakeholders with such participation. Stakeholders are individuals, groups, or organizations interested, involved, or affected by ICOM interventions. Through a participatory stakeholder analysis, it is possible to identify the key stakeholders and assess their characteristics, interests, respective relationships and relative importance in and influence on an ICOM initiative. The stakeholders are identified by the activities directly or indirectly affecting an ICOM initiative and can be divided into primary and secondary stakeholders. Information on stakeholder characteristics, interests and relationships can be organized through the use of tables and diagrams. The level of participation of stakeholders in decision-making processes and activities can be determined by observing their participation in meetings or by conducting a survey. Through a survey, it is possible to investigate the level of satisfaction of stakeholders with their participation in ICOM decision-making processes and activities.

Limitations of the indicator

It might not be easy to identify all the stakeholders relevant to an ICOM initiative, particularly those who are poor, unorganized and powerless. Similarly, it might not be easy to elucidate all the relationships among stakeholders. Often, only unsatisfied stakeholders participate in meetings and some have unrealistic expectations, resulting in a low level of satisfaction. Participation does not equate to satisfaction and this, in turn, does not necessarily guarantee that the best decisions have been made.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

There might be other measures of stakeholder participation and satisfaction, for example, access to environmental information; public participation in decisions on specific activities (such as in EIAs), public participation concerning plans, programmes and policies; public participation during the preparation of executive regulations and/or legally binding normative instruments; and access to justice (Aarhus Convention).

G10 Stakeholder participation

Assessment of data

Data needed to compile the indicator
Results of interviews and surveys, meeting records.

Data sources and collection methods
Interviews and surveys with key informants and reviews of government records.

Analysis and interpretation of results
The results of the stakeholder analysis can be expressed through matrices and tables showing a breakdown by stakeholder groups. Scores of the level of satisfaction resulting from the surveys can be calculated and measured over time to detect changes. Data can be expressed both in quantitative and qualitative terms.

Reporting scale and output
The indicator is best monitored at the level of individual ICOM initiatives. The output may take the form of a stakeholder analysis matrix, stakeholder participation matrix, scores of stakeholder satisfaction with participation, narrative report.

Additional information

Organizations and programmes involved in the development of the indicator
—

References
King, G. (1999). Participation in the ICZM Process: Mechanisms and Procedures Needed. Hyder Consulting, Cardiff.
Olsen, S. and Kerr, M. (1998). Building Constituencies for Coastal Management: A Handbook for the Planning Phase. Coastal Management Report 2214. University of Rhode Island, Coastal Resources Centre, Narragansett, Rhode Island.
Wilcox, D. (1994). The Guide to Effective Participation. Joseph Rowntree, Brighton.

Internet links
—

G11 NGO and CBO activity

Nature of indicator

Definition

The existence of NGOs and community-based organizations – CBOs (formal and informal) and the level of activities in support of ICOM objectives and initiatives.

Unit of measurement

Quantitative and qualitative assessment of the following dimensions:

- The number and characteristics of NGOs and CBOs active in fields related to ICOM;
- The level of activities carried out by the NGOs and CBOs in support of ICOM (participation in meetings, advocacy and awareness raising, field projects, etc.);
- The degree of influence of these activities on the advancement of ICOM.

Relevance

Purpose

The indicator is a measure of the support that major groups such as NGOs and civil society provide to government-driven activities such as ICOM. The indicator should be useful to detect (a) the relative importance of ICOM issues for civil society and its organized institutions such as NGOs; (b) the degree of involvement of these organizations in official ICOM initiatives; and (c) the actual contribution of these activities to the advancement of ICOM and ICOM initiatives. The existence and activity of supportive NGOs and CBOs are vital to the advancement of ICOM, both at the level of individual initiatives and in more general terms. NGOs and community organizations represent resource users and stakeholders and some ICOM activities may also be implemented through NGOs and CBOs. In addition, the presence of NGOs and CBOs in an ICOM initiative is a signal of transparency, participation and representation. This has a value beyond ICOM itself and pertains to the modalities through which to pursue sustainable development.

International conventions, agreements and targets

The role of NGOs and other major groups in sustainable development processes has been extensively recommended by Agenda 21 in its section III. There are no internationally established targets and standards for this indicator.

G11 NGO and CBO activity

Methodological description

Underlying definitions and concepts

The involvement of non-governmental and comunity-based organizations in ICOM may be characterized by the following features:

- NGOs and CBOs exist that are relevant to ICOM;
- NGOs and CBOs are organized to participate in the management of ICOM activities;
- NGOs and CBOs carry out activities relevant to ICOM (co-management, advocacy, awareness raising, field projects, etc.);
- Activities carried out by NGOs and CBOs are actually contributing to advance ICOM and ICOM initiatives.

Measurement approaches

Qualitative and quantitative assessment of the following dimensions:

- The existence of NGOs and CBOs relevant to ICOM;
- The characteristics of such NGOs and CBOs (mission and objectives, functions and responsibilities, period of existence, budget and staff);
- The activities carried out by these NGOs and CBOs (participation in ICOM meetings and advocacy, awareness raising, education and training, field projects, etc.);
- The perceived contribution of such activities to the advancement of ICOM and ICOM initiatives.

Limitations of the indicators

ICOM initiatives are not necessarily carried out through the aid of CBOs. It might therefore be difficult to assess the specific contributions made by NGOs and CBOs to ICOM and ICOM initiatives.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

NGOs and CBOs may take many forms and have different types of involvement in ICOM initiatives. Therefore, the indicator needs to be consistent with the reality of each case to which it is applied.

G11 NGO and CBO activity

Assessment of data

Data needed to compile the indicator
Quantitative and qualitative information on NGOs and CBOs and their activities in support to ICOM.

Data sources and collection methods
NGO directories, meeting minutes, annual reports. Document reviews, surveys.

Analysis and interpretation of results
Narrative report with the list of NGOs and CBOs active in ICOM-related activities, their characteristics (mission and objectives, functions and responsibilities, period of existence, budget and staff), their activities related to ICOM (participation in ICOM meetings and advocacy, awareness-raising, education and training, field projects, etc.) and an appreciation of the actual contribution of these activities to the advancement of ICOM and ICOM initiatives.

Data collection methods
The indicator can be monitored at all scales. The output may consist of a narrative report, supported by sufficient data.

Additional information

Organizations and programmes involved in the development of the indicator
—

References
King, G. (1999). *Participation in the ICZM Process: Mechanisms and Procedures Needed*. Hyder Consulting, Cardiff.
Olsen, S. and Kerr, M. (1998). *Building Constituencies for Coastal Management: A Handbook for the Planning Phase*. Coastal Management Report 2214. University of Rhode Island, Coastal Resources Centre, Narragansett, Rhode Island.
Wilcox, D. (1994). *The Guide to Effective Participation*. Joseph Rowntree, Brighton.

Internet links
—

G12 Education and training

Nature of indicator

Definition

The incorporation of ICOM into educational and training curricula, the number of persons graduating and/or trained with such curricula and the number of persons with such preparation employed in ICOM-related agencies.

Unit of measurement

Quantitative and qualitative assessment of a number of dimensions:

- The number and characteristics (e.g., location, duration, attendance, etc.) of university programmes incorporating ICOM in their curricula;
- The number and characteristics of training courses held that incorporate ICOM;
- The number of people graduating from university programmes incorporating ICOM;
- The number of people having completed training courses incorporating ICOM in their syllabus;
- The number of graduates with an ICOM preparation employed in ICOM-related agencies;
- The number of people having attended ICOM training courses employed in ICOM-related agencies;
- The number of people employed in ICOM-related agencies who had on-the-job training in ICOM;
- Degree of satisfaction of people attending ICOM-related university and training courses;
- Degree of satisfaction of offices having employed persons trained in ICOM.

Relevance

Purpose

ICOM requires new multidisciplinary and management skills. This indicator reflects the degree to which the educational and formative system provides these skills and the degree to which these new skills are requested by ICOM-related agencies. The degree to which education and training is providing such skills and to which the job market associated with ICOM is requesting them is a powerful indicator of the role of these new approaches. Therefore, the indicator, given its specificity, is directly related to ICOM and, in general, to sustainable development.

International conventions, agreements and targets

Agenda 21 clearly recommended that coastal States should promote and facilitate the organization of education and training in integrated coastal and marine management and sustainable development for all types of users and the incorporation of management and development, as well as environmental protection concerns and local planning issues, in educational curricula and public awareness campaigns. Education and training in ICOM should also be part of capacity-building efforts in developing countries. The role of education and training for ICOM is recognized by all other international agreements addressing ICOM-related issues. There are no internationally established targets and standards for this indicator.

G12 Education and training

Methodological description

Underlying definitions and concepts

Education and training for ICOM may be characterized by the following features:

- University programmes specifically targeting ICOM or incorporating ICOM in their curricula;
- Training courses, be they for unemployed or employed people, incorporating ICOM in their syllabi.

Measurement methods

There are four levels of measurement:

1. (a) The number of university programmes incorporating ICOM in their curricula and (b) the number of training courses incorporating ICOM in their syllabi and the characteristics of such programmes and courses (undergraduate/Masters/Ph.D., duration, requirements, etc.);
2. (a) The number of people having successfully completed a university degree (undergraduate/Masters/Ph.D.) encompassing ICOM-related courses and (b) the number of people – distinguished between unemployed and employed in ICOM-related agencies – having successfully completed ICOM-related training courses. This dimension may include also (c) the dissertations completed on ICOM topics;
3. (a) The number of people having successfully completed a university degree encompassing ICOM-related courses employed in ICOM-related agencies and (b) the number of unemployed people having successfully completed ICOM-related training courses employed in ICOM-related agencies;
4. In addition, the level of satisfaction may be measured of (a) people having taken university programmes or training courses in ICOM-related subjects and (b) the ICOM-related agencies employing people having taken university programmes or training courses in ICOM-related subjects.

Limitations of the indicator

The calculation of the indicator is complicated by the difficulty of accessing the data and of delimiting the scope of "ICOM-related" subjects. Moreover, the completion of university programmes or training courses is not by itself synonymous with capacity in ICOM. On the other hand, the employment of people with an ICOM formation does not necessarily translate into better ICOM formulation and implementation.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions/indicators

As an alternative, employment in the private sector, academia and NGOs could also be considered. In addition, the existence of specific fellowships for ICOM studies could be assessed, as well as other mechanisms to promote multidisciplinary education as well as international exchanges, internships, etc. As a proxy for employment, the advertisement of ICOM-related jobs (short-term, permanent, project-based, including in development assistance activities) could be considered.

G12 Education and training

Assessment of data

Data needed to compile the indicator
University records, government agencies employment records, education statistics, results from surveys.

Data sources and collection methods
Universities, vocational training institutions, government agencies, statistical services. Document review, surveys.

Analysis and interpretation of results
Description and quantitative and qualitative analysis of the adequacy and the contribution of education and training activities to form a new cadre of ICOM scientists and managers.

Data collection methods
The indicator can be monitored at the national level and aggregated at the national level. The output may consist of a narrative report corroborated by adequate statistics.

Additional information

Organizations and programmes involved in the development of the indicator
UN, TRAIN-SEA-COAST programme.

References
Crawford, B.R., Cobb, J. S. and Loke Ming, Ch. (1995). *Educating Coastal Managers, Proceedings of the Rhode Island Workshop*. University of Rhode Island, Coastal Resources Centre, Narragansett, RI. (http://www.crc.uri.edu/comm/htmlpubs/ecm/index.html)

Internet links
UN. *TRAIN-SEA-COAST*. http://www.un.org/Depts/los/tsc_new/TSCindex.htm (19/07/2006).

G13 Technology

Nature of indicator

Definition
The use of technology, including environmentally friendly technology, to enable and support ICOM.

Unit of Measurement
Qualitative and quantitative assessment of:
- Availability of technology that can enable and support ICOM at a feasible cost;
- Use of technology to enable and support ICOM initiatives and removal of technology counterproductive for ICOM;
- Coordination of the use of technology to enable and support ICOM.

Relevance

Purpose
Technology can play an important role in ICOM, e.g., in analysis and diagnosis of coastal issues, planning, implementation and evaluation. The role of this indicator is to measure the extent to which the ICOM process and activities are better enabled and supported by the use of technology, including environmentally-friendly technology, how this technology substitutes technology counterproductive for ICOM, and how this process is coordinated.

Relevance to international conventions, agreements and targets
Among other agreements, Agenda 21 recommends that coordination mechanisms for ICOM promote environmentally sound technology and sustainable practices. Scientific and technological means also provide a fundamental base for the implementation of ICOM, including cooperation among states in the development of necessary coastal systematic observation, research and information management systems and provision of access to and transfer of environmentally safe technologies and methodologies for sustainable development of coastal and marine areas to developing countries and the development of technologies and endogenous scientific and technological capacities. The use of clean technology is called for by the GPA, also in relation to the transfer of environmentally sound technologies to developing countries. Among the strategies and measures to achieve the objectives of the GPA are best available techniques (BAT) and practices (BAP), clean production practices, environmentally sound and efficient technologies, product substitution, waste recovery, recycling and waste treatment. The BPOA addresses technology issues in a separate section, but calls for the sharing of expertise on geographic information systems (GIS) techniques and facilities for the assessment of coastal and marine resources.

G13 Technology

Methodological description

Underlying definitions and concepts

Technology for ICOM may include:

- Technology supporting information acquisition and management (aerial photography and satellite remote sensing, global positioning system, GIS, etc.);
- Technology for the exploitation of the coastal space and its resources (e.g., exploration and exploitation of energy and non-renewable resources, pollution reduction and prevention through BAP, BAT and integrated pollution prevention and control, fishery and aquaculture, water and sediment management, climate change and sea level rise adaptation);
- Technology to preserve coastal space and its resources (e.g., treatment and monitoring of sewage, cleaner production processes for persistent organic pollutants, heavy metals and radioactive pollutants, nutrients and non-point pollution, oil pollution emergency, aquifers and salt water intrusion, physical alteration and destruction of habitats, coastal defence and safety, dredging).

Measurement methods

The indicator and its dimensions may be measured in a qualitative and quantitative way on different levels. The first level refers to the need for better and new technologies based on the limitations posed to ICOM by existing technologies. The assessment then addresses: (a) which technologies could best enable and support ICOM and which ICOM phases, components and tasks could be most improved through technology, and (b) which technologies are actually available for introduction and what is their feasibility. The second level refers to the substitution of technologies that are counterproductive for ICOM with ICOM-enabling and supporting technologies. The third level refers to the measurement of the effectiveness of these technologies and the quantification of the environmental, social and economic benefits achieved. The indicator is also associated with the use of voluntary agreements with the private sector for the adoption of environmentally-friendly technologies, economic instruments to stimulate this process, research and development policies and activities, as well as demonstration projects to assess the feasibility and effectiveness of new technologies.

Limitations of the indicator

This indicator is of a general nature and it might not be easy to assess the contribution of technology to enable and support ICOM initiatives. One way to measure the indicator might be considering more closely issues related to the development, transfer and use of environmentally sound technologies for specific uses or environmental problems (use of coastal resources such as fish stocks, technologies to clean up oil spills, facilities for the treatment of waste oil and wastes at ports, treatment of urban wastewaters, etc.) in an attempt to measure how technologies can enable and support ICOM and their effectiveness in delivering more efficiently environmental, social and economic benefits.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions

The concept of "ICOM-enabling and supporting technologies" is extremely broad and attention has to be paid to defining operationally the scope of the indicator.

G13 Technology

Assessment of data

Data needed to compile the indicator
Government, statistical services and enterprise records and statistics, results of interviews and surveys.

Data sources and collection methods
Document review of government records, statistical information, accompanied by interviews and surveys.

Analysis and interpretation of results
The analysis and interpretation of results should focus on one or more the following: (a) the need for technologies that could enable and support ICOM and their feasibility, (b) the determining factors for decisions concerning the use of technologies in ICOM, and (c) the environmental changes brought about by these technologies and their efficiency.

Reporting scale and output
The indicator can be measured at the level of individual ICOM initiatives as well as aggregated at the national scale. The output may consist of a narrative report supported by substantial factual data.

Additional information

Organizations and programmes involved in the development of the indicator
OECD; United Nations Industrial Development Organization (UNIDO); UNEP, Division of Technology, Industry and Economics (DTIE); Mediterranean, Regional Activity Centre for Cleaner Production (RAC/CP).

References
Capobianco, M. (1999). *Role and Use of Technologies in Relation to ICZM*. Tecnomare, Venice.

Internet links
OECD. Technology and Sustainable Development. Sustainable Development. http://www.oecd.org/topic/0,2686,en_2649_34499_1_1_1_1_37425,00.html (19/07/2006).
RAC/CP. Regional Activity Centre for Cleaner Production. http://www.cema-sa.org/car/cat/index.htm (19/07/2006).
UNEP/DTIE. Division of Technology, Industry and Economics. http://www.uneptie.org/ (19/07/2006).

G14 Economic Instruments

Nature of indicator

Definition

The use of economic instruments, in addition to regulatory instruments, to support ICOM.

Unit of measurement

Qualitative and quantitative assessment of the following dimensions:

- The existence and availability of economic instruments for ICOM;
- The actual use of economic instruments in combination with regulatory instruments;
- The effectiveness and efficiency of economic instruments.

Relevance

Purpose

Economic instruments can complement regulatory instruments and, at times, replace them to improve efficiency, integrate environmental considerations into mainstream economic decision-making, reduce environmentally damaging subsidies, stimulate innovation and competitiveness, help internalize environmental costs, support the polluter and user pays principle and, ultimately, promote environmentally sustainable development. ICOM should not be based solely on a command and control approach and needs to make use of economic instruments to correct the market distortions that often are at the base of environmental problems and to help businesses and consumers to make long-term choices.

International conventions, agreements and targets

The Rio Declaration calls national authorities for promoting the internalization of environmental costs and the use of economic instruments (principle 16). Agenda 21 recommends the use of economic incentives to apply clean technologies; the same does the GPA. The OECD has also recommended the use of economic instruments in environmental policies, including for the coastal zone.

G14 Economic Instruments

Methodological description

Underlying definitions and concepts

Economic instruments for ICOM may be of different types, e.g., emission charges (e.g., on household wastewater), water pricing (e.g., for household and industrial waters), fines on discharges from ships, license fees for fishing, boat registration fees, taxes on fertilizers, taxes on land development, reduction of subsidies on polluting activities, subsidies for land conservation, energy pricing for transport activities.

Measurement approaches

The indicator may be measured on different levels. The first level refers to the availability of economic instruments that could beneficially be utilized to support ICOM policy objectives or address specific environmental problems. At this level, the appropriate conditions for the introduction of economic instruments are also assessed. The second level refers to the actual use of these economic instruments to support ICOM policies and objectives. The third level refers to the benefits achieved through the use of economic instruments. This dimension may refer to specific sectors or environmental problems and has to be measured in relation to environmental and socioeconomic indicators.

Limitation of the indicator

The indicator is of a broad and long-term scope. It might be difficult to measure it in relation to specific ICOM initiatives rather than in relation to general environmental policies, including for water, land and natural resource management.

Status of the methodology

There is currently no internationally agreed methodology for the indicator in its application to ICOM. However, there is substantial literature on the use of economic instruments developed by OECD as part of a country's environmental performance reviews.

Alternative definitions

Among economic instruments, voluntary agreements with the private sector may be included, as well as the use of environmental quality certifications (e.g., ISO 14000 on environmental management and Environmental Management and Audit Schemes). These certifications could constitute a specific indicator

G14 Economic Instruments

Assessment of data

Data needed to compile the indicator

Quantitative and qualitative information on the use of economic instruments for coastal and marine uses (water and land use, natural resource management), as well as on the type and number of voluntary agreements between governmental authorities and the private sector(s) and the environmental certifications.

Data sources and collection methods

Review of business, chamber of commerce and government records and databases, monographs and databases by intergovernmental organizations (OECD, UNIDO) accompanied by interviews and surveys.

Analysis and interpretation of data

The analysis and the interpretation of data should focus, where possible, on the measurable changes brought about by the introduction of economic instruments and voluntary agreements for the use of clean technologies.

Reporting scale and output

The indicator can be monitored at the national scale. The output may consist of a narrative report, including tabular data.

Additional information

Organizations and programmes involved in the development of the indicator

OECD (global); PAP/RAC (Mediterranean).

References

Grigalunas, T.A. and Congar, R. (Eds.) (1995). Environmental Economics for Integrated Coastal Area Management: Valuation Methods and Policy Instruments. UNEP Regional Seas Reports and Studies 164. UNEP, Nairobi.
METAP (2002). Participation and Financing as Mechanisms for Improving Sustainability of Integrated Coastal Zone Management. Helsinki: Finnish Environmental Institute.
PAP/RAC (2002). Analysis of the Application of Economic Instruments for Combating the Land-Based Pollution in the Mediterranean Coastal Areas. PAP/RAC, Split.
UNEP (2004). Use of Economic Instruments in Environmental Policy: Opportunities and Challenges. UNEP, Nairobi.

Internet links

OECD/EEA. OECD/EEA database on economic instruments and voluntary approaches used in environmental policy and natural resources management. Environment. http://www1.oecd.org/scripts/env/ecoInst/index.htm (19/07/2006).
PAP/RAC. Database on economic instruments in the Mediterranean. PAP/RAC. http://www.pap-sapei.org/ (19/07/2006).

G15 Sustainable development strategy

Nature of indicator

Definition

The integration of ICOM into the national (or regional) strategy for sustainable development, fully recognizing the value of coastal and marine resources and the role they play in development.

Unit of measurement

Quantitative and qualitative assessment of a number of dimensions:

- Existence of a national sustainable development strategy;
- Role of ICOM in the strategy;
- Level of implementation and degree of effectiveness;
- Existence of performance targets and indicators;
- Availability of funds for ICOM implementation;
- Cross-sectoral projects.

Relevance

Purpose

The integration of ICOM into the national sustainable development strategy reflects the commitment to ensure the protection and development of coastal and marine areas in the broader context of a national sustainable development strategy through a more integrated economic, social and environmental policy planning. The indicator is precisely the expression of the integration of ICOM into sustainable development: the national sustainable development strategy integrates priorities in the social, economic and environmental sectors and in this sense can enhance national prospects for economic growth and employment while protecting the environment. The role of ICOM in this process expresses the commitment to protecting and managing coastal and marine resources in a sustainable and strategic way.

International conventions, agreements and targets

Agenda 21 calls for the implementation of national sustainable development strategies and the integration of environment and development in decision-making, as well as for the integrated management and sustainable development of coastal areas, including exclusive economic zones. More recently, the JPOI recommended the development of integrated, multidisciplinary and multisectoral coastal and ocean management at the national level. There are no internationally established targets and standards for this indicator.

G15 Sustainable development strategy

Methodological description

Underlying definitions and concepts

The mainstreaming of ICOM into sustainable development strategies may be reflected by the following:

- ICOM chapter included in the sustainable development strategy;
- ICOM-related objectives integrated in the economic, social and environmental sectors;
- Coordination mechanism or body encompassing ICOM interests;
- ICOM priorities and outcomes included in the strategy;
- ICOM activities targeted with clear budgetary priorities;
- Multi-stakeholder participation and effective partnerships in ICOM-related activities;
- Engagement of a high political level (e.g., Ministry of Planning and Finance);
- Implementable and with short-term and tangible objectives, including a plan for internal and external resource mobilization;
- Transparency and accountability through continuous monitoring and evaluation.

Measurement approaches

There are two levels of measurement:

1. The existence of an ICOM chapter within a sustainable development strategy;
2. The extent to which the ICOM chapter is being implemented and its effectiveness.

The first level can be monitored by examining the national sustainable development strategy or, in its absence, other relevant strategies, plans and activities.

The second level requires the examination of the monitoring and evaluation component of the strategy or, in its absence, ICOM activities themselves, in relation to other strategies, plans and programmes.

Limitations of the indicator

There are no internationally agreed standards regarding what constitutes a sustainable development strategy and the mainstreaming of ICOM within it. The indicator is essentially of a qualitative nature and additional criteria will have to be developed to measure the implementation and effectiveness of the ICOM component of the strategy. In addition, multiple strategies, plans and programmes may be in existence as supplement to the sustainable development strategy.

Status of the methodology

There is currently no internationally agreed methodology for this indicator.

Alternative definitions/indicators

A wide variety of planning and strategy formulation processes is in use in different countries. What matters to the development of the indicator is the integration of the key economic, social and environmental dimensions of development into one or multiple strategies and specific priorities, targets, measures and means of implementation for ICOM within these strategies.

G15 Sustainable development strategy

Assessment of data

Data needed to compile the indicator
National country reports, policy reports, legislative reports and various planning documents.

Data sources and collection methods
Reviews of documents from government planning and environment ministries, interviews and surveys.

Analysis and interpretation of results
Description, qualitative and if possible quantitative, analysis of the importance of ICOM within sustainable development strategies. The output may consist of a narrative report.

Reporting scale and output
The indicator can be measured at the national scale. The output may consist of a narrative report.

Additional information

Organizations and programmes involved in the development of the indicator
UNCSD is the agency in charge of monitoring the implementation of national sustainable development strategies, including for oceans and the coastal zone.

References
Carew-Reid, J., Prescott-Allen, R., Bass, S.M.J. and Dalal-Clayton, D.B. (1994). *Strategies for National Sustainable Development: A Handbook for their Planning and Implementation*. IIED and IUCN, London and Gland.

Dalal-Clayton, B. and Bass, S. (2002). *Sustainable Development Strategies: A Resource Book*. IIED and OECD, London and Paris.

OECD (2001). *Strategies for Sustainable Development: Practical Guidance for Development Cooperation*. OECD, Paris.

UNDESA (2002). *Guidance in Preparing a National Strategy for Sustainable Development: Managing Sustainable Development in the New Millennium*. DESA/DSD/PC2/BP13. UN, New York.

UNGA (2001). *Road map towards the implementation of the United Nations Millennium Declaration Report of the Secretary-General. A/56/326.* UN, New York.

Internet links
UNDESA. National Information. Sustainable Development Issues. http://www.un.org/esa/sustdev/natlinfo/natlinfo.htm (19/07/2006).

UN. Sustainable Development. Atlas of the Oceans. http://www.oceansatlas.com/unatlas/uses/uneptextsph/wastesph/2240susdev.html (19/07/2006).

DRIVERS Uses of the Marine Environment	PRESSURES Human Activities of Concern	STRESSORS (incl. main sources, processes and pathways)	ISSUES Threats and impacts on ecosystem properties
Land-based activities	Agriculture, forestry Chemical and fish processing plants Hydro-electricity (i.e., upstream dams)	- Nutrients and contaminants inputs (e.g., pesticides) - Untreated or partially treated industrial sewage may cause organic enrichment in water and surface sediments; introduce toxic chemicals, which degrade very slowly and bioaccumulate in the food web - Changes in freshwater flows into coastal areas (estuaries, bays, etc.)	= Eutrophication of coastal waters (i.e., natural nutrient level exceeded) = Hypoxia: increase in BOD may cause direct mortalities and/or affect the biological components (biodiversity and productivity) and the overall marine environmental quality = Pollution of coastal waters may affect the overall marine environmental quality = Regime shifts may affect key physical properties like salinity, local currents, or suspended materials, in turn influencing biodiversity (species distribution) and productivity (biomass) of impacted areas
Harvesting of biological resources	Fishing Aquaculture (fish and shellfish)	Direct result of fishing is the removal of a significant part of the biomass otherwise available to the rest of the food web. When/where not properly managed (e.g., overfishing), can result in fish stock depletion - Commercial fishing also harvests non-target species (reducing biomass available for higher trophic levels) and usually discards fish and fisheries wastes - Fishing of forage species (e.g., industrial fisheries) removes a significant portion of fish biomass, otherwise available for predators at higher trophic levels - Bottom disturbance may be due to physical-chemical changes (e.g., organic enrichment under aquaculture facilities, smothering of sediment) or physical disturbance (e.g., bottom trawling) - A great variety of toxic compounds from aquaculture (biocides and therapeutants) and fishing (e.g., fuel, TBT) may be introduced in the coastal environment - Disease vectors may be introduced by aquaculture	Overfishing has direct impacts on productivity of coastal and marine ecosystems, as well as on biodiversity and food webs (e.g., unbalanced prey-predators relationships) = Incidental catches (by-catch) may have direct impact on productivity (fish) or individuals (marine mammals) of non-target species or populations, incl. species at risk = Fisheries discards contribute to pollution (addition of organic matter) of the coastal and marine environment and locally affect seawater quality = May affect productivity and trophic structure (e.g., change in composition of higher trophic levels) = Habitat quality is degraded (locally) by drastic changes in physical and chemical properties of water and sediments with consequences on local biota and biodiversity and productivity of impacted areas = Contaminants: Increasing levels of contaminants locally; therapeutants may also affect wild species with unknown impacts on biodiversity = Marine environmental quality (Ecosystem health issue), and human health ultimately can be affected by marine diseases = Biodiversity (genetic diversity) and health of wild populations may be impacted

DRIVERS Uses of the Marine Environment	PRESSURES Human Activities of Concern	STRESSORS (incl. main sources, processes and pathways)	ISSUES Threats and impacts on ecosystem properties
	Marine mammals and water-fowl hunting Plant harvesting Bio-prospecting	- Wild population genetics can be widely affected by escapees from aquaculture facilities at sea - Selective hunting can threaten targeted species if not properly managed - Removing a significant portion of the biomass of key species which have a structural and functional role in the ecosystem (e.g. Fucus, Laminaria) can lead to unbalance in the benthic community - Harvesting can also disturb the upper layers of benthic habitats - Bio-prospecting targets (harvests) specific individuals or populations	= Biodiversity may be threatened if this activity is not properly managed or regulated = Productivity of the coastal environment may be affected, as well as physical habitat features = Overall productivity and trophic structure of the ecosystem may be affected = Habitat degradation (very local; affecting mainly the intertidal zone and upper) = Change in biodiversity (genetic and species diversity) over time; may be a species at risk issue = Potential threat to biodiversity
Extraction of non-renewable resources	Oil & gas activities (incl., exploration, exploitation and decommissioning phases) Mineral extraction, mining	- Oil spills: immediate and drastic impacts are due to physical effects on coastal habitats and communities, mainly benthos and seabirds (i.e., vast amounts of oil released within a very short period of time); there are also delayed /chronic impacts due to chemical effects of toxic compounds like PAHs - Release of a wide variety of contaminants (hydrocarbons, lubricants, metals, etc.) into the water column and surface sediments (locally) directly from the seafloor (oil seeps, waste and production waters) - Produced mud change the nature of sediment (e.g. smothering) around facilities - Physical disturbance of bottom (locally) by mineral extraction and mining activities, as well as oil & gas facilities, platforms, wells, etc. - Mineral extraction, mining, etc. may lead to an increase in suspended sediment and reduce the light availability (locally)	= Acute effects: Ecosystem properties like productivity, biodiversity and environmental quality are impacted more or less (effects are located within the oiled area and may last from weeks to years, depending on the affected species) = Contaminants levels increase in areas around facilities and wells; chemical properties and water and sediment and quality are locally affected = Changes in sediment properties affect the benthic habitat quality, in turn reducing the biodiversity of the impacted area = The bottom disturbance (locally) may lead to habitat loss and fragmentation = Primary productivity is likely affected locally

Annex II

Major human activities, associated stressors and potential impacts on ecosystem properties and associated environmental issues

DRIVERS Uses of the Marine Environment	PRESSURES Human Activities of Concern	STRESSORS (incl. main sources, processes and pathways)	ISSUES Threats and impacts on ecosystem properties
Transportation and communications (i.e., corridor-based uses)	Shipping (incl., cruise ships and ferries) Harbours and shipyards facilities Channel maintenance and dredging Cables and pipelines	- Introduction of exotic species (alien invasive species) from ballast waters exchange - Sewage and wastewaters released from ships, mainly cruise ships (as little towns moving in pristine environments) - marine mammal harassment - Releases of contaminants (e.g. paints, solvents, TBT, oil spills, most of the time minor but continous) - Result in bottom disturbance (locally) and increase in suspended matter and turbidity (around) - physical disturbance of the bottom	= Biodiversity is affected by exotic species: Changes are expected in the composition of communities and trophic structure = Marine environmental quality is likely affected in visited areas = May be important factor for species at risk = Affect the water column and sediments quality around = Lead to habitat fragmentation and loss of coastal seascape integrity = Turbidity may lead to reduce the primary productivity locally (and temporarily) = Habitat fragmentation
Public use of the coastal environment (i.e., coastal populations and recreational activities)	Coastal development (e.g. marinas, coastal defence infrastructures, tourism, coastal cities and urban sprawl, roads and access to littoral) Municipal sewage Recreational fishing Eco-tourism (e.g. access to marine protected areas/coastal parks, educational activities and wildlife observation), boating, kayaking, scuba-diving, snorkelling, etc.	- May lead to disturbance, degradation or loss of coastal habitats (incl., fragile, sensitive or critical habitats) - Increase in suspended sediments and turbidity (locally) - Untreated or partially treated sewage may lead to exceed safe levels of bacteria (coliforms), pathogens, and disease vectors in coastal waters, in addition to the release of high loads of organic matter and contaminants - Selective harvest of species may affect the biomass of targeted species or populations; and possible harassment of targeted species and individuals - Harassment of marine wildlife; pressures on fragile (coastal) ecosystems - Release of waste, debris, etc.	= Habitat fragmentation, or habitats loss = Decrease in ecosystem diversity, productivity and environmental quality = Loss of coastal landscapes integrity = Decrease in primary productivity and indirect impacts on higher trophic levels = Introduction of various types of pollutants may have cumulative impacts (and even synergistic effects) on local biota and the overall marine environmental quality in relation to issues such as seafood quality, harmful algal blooms (HABs), marine diseases, and associated threats to human health = The productivity of the ecosystem may be affected = Species/populations at risk or their critical habitats may be affected = Threatening the most sensitive/exposed species: this may be an important factor in relation to biodiversity and species at risk issue = The habitat quality, incl. the shoreline integrity, may be affected

DRIVERS Uses of the Marine Environment	PRESSURES Human Activities of Concern	STRESSORS (incl. main sources, processes and pathways)	ISSUES Threats and impacts on ecosystem properties
Others sea-based activities	Energy production (wind power, tides, etc.) Supporting activities: e.g., Research and monitoring, research & rescue, surveillance and enforcement, ice-breaking, defence, etc. Ocean dumping	- Harassment of marine wildlife (migratory species like fish, seabirds or marine mammals are particularly vulnerable - Harassment of marine wildlife by ship traffic, noise, sampling, etc. (e.g., repetitive activities within limited areas) - Release of toxic substances or materials in deep-sea environments; increase the level of toxic compounds in pristine environments	= Species/populations at risk may be affected = Loss of coastal landscapes/seascapes integrity = Additional pressures, i.e., cumulative impacts on sensitive and/or unique coastal and offshore ecosystems (e.g. mangroves, hydrothermal vents, coral reefs) = Pollution: Chemical properties of seawater and sediment may be affected
"Locally non-controllable" driving forces	Global warming and climate change Ozone hole and UV radiation Long-range transport of pollutants	- Direct impacts are sea level rise (which in turn can lead to more frequent flooding of coastal areas in estuaries and islands, accelerate erosion with an increase in turbidity, etc., change in water temperature and regime shifts - Change in UV spectrum available in surface waters can affect primarily plankton organisms, mainly micro-algae, which need specific wavelengths to develop but are sensitive to other harmful ones - Introduction of a great variety of contaminants in specific areas far away from sources (incl. remote areas)	= Significant portions of coastal habitat may be lost or degraded, in turn affecting the biodiversity and productivity of the coastal ecosystem = Decrease in water and habitat quality = Impact on landscapes integrity = Primary productivity may be directly affected at large scales, with direct consequences on secondary and higher trophic levels and trophic structure. Biodiversity may be also affected = Pollution of large scale marine areas; very difficult to go back to sources and know contaminants pathways and processes; seawater, sediment and biota quality (e.g., bioaccumulation in food web up to humans; human health issue) can be affected

E1 Biological diversity

Nature of indicator

Definition

The biological diversity (or biodiversity) is the variability among living organisms in terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; biodiversity includes genetic diversity, species diversity and ecosystem diversity.

Unit of measurement

Biological data at the species level (i.e., individuals and populations), community level (e.g., biological assemblages of several species and taxonomic groups), as well as sub-species level (cellular measurements).

Relevance

Purpose

Biodiversity is a key component of the overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of the organization of the ecosystem. This assessment is needed to ensure that the management objective of maintaining ecosystem structure is met.

International conventions, agreements and targets

Convention on Biological Diversity (CBD) – United Nations Environmental Programme (UNEP) (1992);
CBD Jakarta Mandate on Marine and Coastal Biodiversity (CBD-Conference of Parties, 1995).

E1 Biological diversity

Methodological description

Underlying definitions and concepts

Genetic and species diversity: The genetic diversity is the "within species" diversity whereas the species diversity is the diversity between species. Although true genetic diversity measurements (e.g., genetic markers like DNA) are fundamental in aquaculture R&D (e.g., breeding strains for best marketable products), as well as in discriminating commercial populations for fisheries management purposes (Waples et al., 2001; McPherson et al., 2001), most biodiversity indices that are routinely used to monitor marine biodiversity relate to species diversity (Costello et al., 2004).

Biological diversity may be also greatly affected by the introduction of invasive alien species. They can lead to significant changes in ecosystem structure and function (see Indicators E 4, E 5, E 7), and monitoring them should be considered an integral part of the assessment of threats to overall biodiversity.

Ecosystem diversity: Ecosystem diversity may be defined by the variety of attributes that characterize an ecosystem - geology, biology, ecology, or physical oceanographic properties.

Measurement approaches

There are five categories of measurements related to the biodiversity indicator: Diversity of communities;
Diversity of populations; Diversity of species; Genetic diversity; Invasive species and pests.

Limitations of the indicator

Most biodiversity measurements focus on species diversity. Very few indicators have been developed and tested for assessing genetic and ecosystem diversity. Although ecosystem diversity may be captured by the number and diversity of habitat types and features, biological communities, as well as the variety of physical oceanographic attributes that characterize a marine ecosystem, it is unlikely that monitoring only higher levels of biodiversity (species and ecosystem levels) can adequately assess genetic diversity. Therefore, a complete biodiversity reporting and assessment framework should ideally also include indicators such as genetic markers (Australia Department of the Environment, 1998). However, these types of measurements require a strong science support and sophisticated/costly equipment, which are not always available.

Status of the methodology

See the review of Costello et al., (2004).

Alternative definitions

—

E1 Biological diversity

Assessment of data

Data needed to compile the indicator

To make biodiversity measurements as informative and reliable as possible, all key components of the ecosystem should be considered i.e., main taxonomic groups in pelagic and benthic domains and living in various types of habitats (see: Indicator E9).

Measuring genetic diversity for ICOM purposes will not necessarily require costly genetic analysis per se because phenotypic measurements (i.e., based on morphological and physiological attributes, most of which are visible) actually result from both the environmental and genetic influence, and therefore can be considered as acceptable proxies for assessing the "within species" diversity in the marine environment (Costello et al., 2004). On the other hand, measuring the diversity of species involves counting the number of individuals or the relative abundance of species within a given community (or any other sampled reference unit). Species richness and species dominance are the simplest, most useful and also most widely used indices of diversity (Costello et al., 2004). Very simple measurements such as the presence/absence, dominance (or evenness or rarity) of a species in a given area may be considered as the first indication of the species diversity.

For ecosystem diversity, most of the ecosystem-level attributes and properties will be covered by the other ecological indicators. In the management context, these attributes may be also used as criteria for the delineation of ecological regions, the spatial framework and science-based foundation, for further implementing ecosystem-based management (Powles et al., 2004).

Data sources and collection methods

Data is compiled from species inventories, samplings, monitoring programmes, etc. The focus should be on species of interest (including alien species) and of ecological importance (keystone species), species at risk, fragile or sensitive species, species exposed to a specific threat, commercial stocks, etc. The various measurements of species diversity should be monitored over time to allow comparison with reference sites and assessments of changes in biodiversity.

As soon as invasive species are detected within the management area, systematic monitoring is needed to assess their extent and inform managers and stakeholders so that appropriate management actions can be taken. However, monitoring of invasive species, mainly for early warning purposes, presupposes that the indigenous flora and fauna are known well enough to serve as reference data. A systematic tracking of the most frequently reported invasive species worldwide, supported by a literature review and knowledge about the main vectors and optimum ecological conditions for those species (in parallel with Indicators E8 and E9), can help address this issue.

E1 Biological diversity

Assessment of data

Analysis and interpretation of data

It is important to develop and use genetic diversity indicators within ICOM to determine if the overall goal of maintaining the natural resilience of the ecosystem is met. Measuring ecosystem diversity implies that a wide variety of attributes and properties must be taken into consideration at the ecosystem level. This type of measurement is likely one of the best approaches to come up with a truly integrated assessment of the structure and function of the marine ecosystem as a whole.

Graphical methods may be very useful to complement basic measurements; the most common approach is species abundance curves (e.g., 'k-dominance' curve). The comparison of these curves between sampling sites or at the same site over time may be of great utility in assessing changes in biodiversity.

Measurements of invasive species can be simply early warning signals (e.g., presence/absence of invasive species in a given area), may indicate how important is the threat (e.g., number, diversity and life history of invasive species), or may be used to assess the spatial extent (e.g., number and coverage of area colonized by invasive species). In addition, changes in these parameters over time are very useful to assess current trends and predict future impacts on the threatened communities or ecosystem. The role of management is particularly crucial when it is to manage the harvesting of living resources that are suspected to be impacted by invasive species.

Reporting scale and output

Biodiversity is an emergent property of the ecosystem, i.e., a property that emerges at the ecosystem level and plays a key role in the structure and resilience of the ecosystem (Costanza et al., 1998). It must be therefore reported at as large as possible a scale (i.e., the management area or larger when possible). Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (e.g., species inventories), figures and graphs (statistics on species, trends) and maps (species distribution). Ecological Indicators reports should be regularly updated to capture environmental changes, impacts of activities as well as progress made (evaluation of the ICOM effectiveness) and fill knowledge gaps.

E1 Biological diversity

Additional information

Organizations and programmes involved in the development of the indicator

- Australia Department of the Environment, e.g., report cited in the text;
- Census of Marine Life (CoML);
- Global Ocean Observing System – Coastal Oceans Observation Panel (GOOS-COOP);
- H. John Heinz III Centre, e.g., The State of the Nation's Ecosystems (2002)/ Coasts and Oceans chapter;
- International Council for Exploration of the Sea (ICES), e.g., the proposed framework for monitoring the status of ecosystem components. ICES Advisory Committee on Ecosystems (2004);
- Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), e.g., A Sea of Troubles (2001) by GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO/WHO/IAEA/UN/UNEP, Reports and Studies No. 70, 35 p; Biological indicators and their use in the measurement of the condition of the marine environment; (GESAMP Report No. 55, 1995); The state of the marine environment (GESAMP Report no.39, 1990);
- OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic, e.g., OSPAR Quality Status Reports series.

References

Costanza, R., Mageau, M., Norton, B. and Pattern, B.C. (1998). Predictors of ecosystem health. In *Ecosystem Health*, Rapport, D., Costanza, R., Epstein, P.R., Gaudet, C. and Levins, R. (Eds.), Blackwell Science, Malden (MA), USA, 240-250.

Costello, M. J., Pohle, G. and Martin, A. (2004). *Evaluating Biodiversity in Marine Environmental Assessments*. Canadian Environmental Assessment Agency (CEAA) Research and Development Monograph Series 2001. Published on the CEAA website: www.ceaa-acee.gc.ca

Australia Department of the Environment. (1998). Environmental indicators for national state of the environment reporting – Biodiversity. *State of the Environment (Environmental Indicator Reports),* Department of the Environment, Canberra, Australia, 68 p.

McPherson, A.A., Stephenson, R.L., O'Reilly, P.T., Jones, M.W. and Taggart, C.T. (2001). Genetic diversity of coastal Northwest Atlantic herring populations: implications for management. J. *Fish Biology*, 59 (Suppl. A), 356-370.

Powles, H., Vendette, V., Siron, R. and O'Boyle, R. (2004). Proceedings of the Canadian Marine Ecoregions Workshop, Ottawa, March 23-25, 2004. Department of Fisheries and Oceans (Canada), Canadian Science Advisory Secretariat (CSAS) Proceedings Series No. 2004/016, 47 p. (report available at: www.dfo-mpo.gc.ca/csas/).

Waples, R.S., Gustafson, R.G., Weitkamp, L.A., Myers, J.M., Johnson, O.W., Busby, P.J., Hard, J.J., Bryant, G.L., Waknitz, F.W., Neely, K., Teel, D., Grant, W.S., Winans, G.A., Phelps, S., Marshall, A. and Baker, B.M. (2001). Characterizing diversity in salmon from the Pacific Northwest. *J. Fish Biology*, 59 (Suppl. A), 1-41.

Internet links

CoML: http://www.coml.org
OSPAR: http://www.ospar.org
CBD: http://www.biodiv.org/default.shtml
ICES: http://www.ices.dk/indexfla.asp
GOOS: http://ioc.unesco.org/goos/

E2 Distribution of species

Nature of indicator

Definition
Distribution of species may refer to both the spatial extent and trophic level of the species. In the 3-dimensional marine environment, the spatial extent includes both the horizontal (distance) and vertical (depth) distributions. The trophic level of the species may be considered as the "vertical" place of the species within the marine food web.

Unit of measurement
Biological data at the species, population and community levels.

Relevance

Purpose
Species distribution is a key component of overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of the organization of the ecosystem. This assessment is needed to ensure that the management objective of maintaining the ecosystem structure is met.

International conventions, agreements and targets
FAO Code of Conduct (1995); Reykjavick Declaration on Responsible Fisheries (2001).

Methodological description

Underlying definitions and concepts
This indicator is based on the over-arching concept of species as the fundamental unit of life (CBD, 1992). Species are then quantified on two key dimensions: the spatial scale (spatial distribution of species in the marine environment) and interactions between species.

Measurement approaches
There are two categories of measurements related to this indicator: Horizontal distribution of species (i.e., patchiness, aggregation); vertical distribution (trophic level) of species (i.e., within the food web).

Limitations of the indicator
Until now, the development and use of this indicator has been mainly in fisheries management, to report on the status and ecology of commercial species (e.g., fish stock assessments) or on top predator-prey relationships. Scientific investigation on the ecology of species at risk and invasive species is increasing. As result, most of the knowledge concerns the distribution of commercial species (fish and shellfish), species at risk (e.g., marine mammals) or invasive species. Very little is known on the other groups of species. Also, the spatial heterogeneity in scientific efforts might introduce bias in terms of comparison between areas (i.e., data rich versus data poor areas). The risk may be that the resulting assessment of this indicator will not truly reflect the actual state of the communities and ecosystems (i.e., in terms of species distribution), but the result of specific interests in certain areas of the marine environment.

Status of the methodology
—

Alternative definition
—

E2 Distribution of species

Assessment of data

Data needed to compile the indicator

Data needed to compile the species distribution are similar to those for the measurement of biodiversity (Indicator E1). Note that vertical distribution measurements must be done in conjunction with trophic interactions (Indicator E5).

Data sources and collection methods

Data sources and collection methods are the same as for the measurement and monitoring of biodiversity.

Analysis and interpretation of data

In certain areas or regions, the lack of data should not be interpreted as a lack of species, but as the disparity of scientific research and monitoring efforts or local/regional community interests.

Reporting scale and output

Like biodiversity measurements, the reporting scale should be as large as possible, covering the entire management area. However, within coastal management areas, where fine-scale distribution patterns are observed and deemed ecologically important (e.g., aggregations, patchiness, unique habitats, structural or functional areas) they should be clearly identified, for example, as biologically and ecologically significant areas for further management actions (DFO, 2004) or even as the resulting impact of an activity (e.g., habitat fragmentation, recolonization of impacted substrates) (see also Indicator E.9).

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (quantitative data), figures and graphs (histograms, comparisons of sites or periods), maps (species distribution and patterns), images (e.g., aerial photographs for reporting on marine mammals or seabird aggregations). Ecological indicators reports should be regularly updated to capture environmental changes, impacts of activities as well as progress made (evaluation of the ICOM effectiveness) and fill knowledge gaps.

Additional information

Organizations and programmes involved in the development of the indicator

- Fifth International Conference on the Protection of the North Sea. (Bergen Declaration, 2002). See ECOQOs proposed to the North Sea pilot project;
- ICES, e.g., the proposed framework for monitoring the status of ecosystem components. ICES Advisory Committee on Ecosystems (2004);
- FAO, e.g., Fisheries Management – 2. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries, 4, Suppl. 2, FAO, Rome, (2003), 112 p.

References

CBD (1992). Convention on Biological Diversity – United Nations Environment Programme (UNEP).

DFO (2004). *Identification of Biologically and Ecologically Significant Areas*. Department of Fisheries and Oceans (Canada), Canadian Science Advisory Secretariat (CSAS), Ecosystem Status Report No. 2004/006, 15 p. (report available at: www.dfo-mpo.gc.ca/csas/).

Powles, H., Vendette, V., Siron, R. and O'Boyle, R. (2004). Proceedings of the Canadian Marine Ecoregions Workshop, Ottawa, March 23-25, 2004. Department of Fisheries and Oceans (Canada), Canadian Science Advisory Secretariat (CSAS) Proceedings Series No. 2004/016, 47 p. (report available at: www.dfo-mpo.gc.ca/csas/).

Internet links

ICES: http://www.ices.dk/indexfla.asp

CBD: http://www.biodiv.org/default.shtml

FAO: http://www.fao.org

E3 Abundance

Nature of indicator

Definition

The abundance of living organisms may be expressed as the quantity of living organisms or living matter (i.e., the biomass, number of individuals, new organic matter produced by marine organisms) that is present in a given unit – population, area or volume of water column.

Unit of measurement

For this indicator, the focus is on species (individuals and populations) and assemblages (communities of species) quantified relative to a spatial (area or volume) reference unit. It can be expressed as numbers of individuals (e.g., in a marine mammal population) or density (number of individuals in a reference volume of water column (e.g., number of planktonic organisms/litre) or within a reference area or unit (e.g., number of benthic plants or algae per unit surface area).

Relevance

Purpose

Abundance is a key component of overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of the organization of the ecosystem. This assessment is needed to ensure that the management objective of maintaining the ecosystem structure is met.

International conventions, agreements and targets

—

Methodological description

Underlying definitions and concepts

Measurement approaches

There are three categories of measurements related to this indicator: Biomass (of key populations); Number of individuals (marine mammals); Density (plants, benthic organisms).

Limitations of the indicator

This indicator gives the current snapshot of the abundance of species or biomass present in the ecosystem at the time when the measurement is made. The abundance can vary greatly over time, e.g., depending on seasons and life cycles, as well as biological and physical processes like grazing and predation, availability of food, changes in oceanographic properties, environmental conditions, etc.

Status of the methodology

—

Alternative definitions

—

E3 Abundance

Assessment of data

Data needed to compile the indicator

The same kind of data as for other biological indicators is needed to compile the indicator: abundance is based on scientific data and knowledge (including local and traditional ecological knowledge) on species, populations and communities found in the management area.

Data sources and collection methods

Most of data will come from systematic monitoring programmes and surveys. Here again, it will likely be easier to collect data on commercial species than on species or populations that are not directly targeted by human activities.

Analysis and interpretation of data

This indicator is a measure of the quantity of living organic matter available to higher trophic levels or for harvesting, but gives no indication on how the ecosystem is structured or how it works. In this respect, the abundance should be monitored and interpreted with other biological indicators of ecosystem structure (organization) and function (vigour).

Reporting scale and output

Since the abundance of species or biomass are measured in a given reference area, it may be wise to report on this indicator at various scales or the most appropriate scale based on both the types of measurement and species distribution (see: Indicator E2). For example, the abundance of marine mammals should be measured within their distribution area, which may be even larger than the management area; the biomass of fish stocks will be measured in populations of interest, with the scale adjusted to the scale of the area frequented by the population, whereas the density of benthic organisms may be reported at finer scales such as a bay, a shellfish bed, an eelgrass bed, coral or sponge reef.

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (quantitative data), figures and graphs (histograms, comparisons of sites or periods, statistics, trends), maps (species abundance and patterns), images (e.g., aerial photographs for counting number of individuals in marine mammal populations). Ecological indicator reports should be regularly updated to capture environmental changes, impacts of activities, as well as progress made (evaluation of the ICOM effectiveness) and to fill knowledge gaps.

Additional information

Organizations and programmes involved in the development of the indicator

See Biodiversity Indicators E1 and E2

References

See Biodiversity Indicators E1 and E2

Internet links

See Biodiversity Indicators E1 and E2

E4 Production and reproduction

Nature of indicator

Definitions

Production is the formation of living organic matter from basic chemicals like nutrients and carbon dioxide (primary production by plants) or the transformation of vegetal matter into animal matter (secondary production).

Reproduction is the natural process that ensures life and continuity of species. This generic term includes several associated biological concepts (e.g., life stages, survival rate, mean generation time) that refer to important processes or properties, which all have a key role at certain periods of the life cycle and which managers may want to consider for assessing ecosystem functioning.

Unit of measurement

Measurement is conducted at species, population or community levels.

Relevance

Purpose

Production and reproduction are key components of overall ecosystem health. Monitoring this indicator will contribute to the assessment of the vigour of the ecosystem. This assessment is needed to ensure that the management objective of maintaining the ecosystem function is met.

International conventions, agreements and targets

CBD (1992) – UNEP.

E 4 Production and reproduction

Methodological description

Underlying definitions and concepts

Primary production forms the basis of marine food chains. In the marine environment, photosynthetic organisms, mainly the phytoplankton in the pelagic domain and macroalgae in the benthos, produce living organic matter - from nutrients and carbon dioxide – that is available to secondary producers. From an ecosystem health point of view, primary production should be assessed in terms of both the quantity (e.g., biomass of phytoplankton) and quality (e.g., species composition in algal communities). Chlorophyll-a concentration in the water column is the most commonly used surrogate to quantify phytoplankton abundance (see also Indicator E3). In the benthos, the biomass of macroalgae, as well as the growth and production rates, is often measured to assess the primary production available to consumers. Primary production may be drastically altered when the phytoplanktonic community is unbalanced, e.g., by an excess of nutrients (eutrophication), which may lead to catastrophic events like "red tides" and "harmful algal blooms", or by contaminants (see: Indicator E8).

An excess of nutrients, or changes in the relative amounts of different nutrients can stimulate the growth (and possibly intense blooms) of phytoplankton species, producing the well known "red-tides". A few phytoplanktonic species produce toxins; their blooms are called "harmful algal blooms" (HABs). These bio-toxins can accumulate in shellfish and poison animals or people who eat them. There are indications that HABs are increasing worldwide (GESAMP, 2001a). Because high concentrations of toxins can accumulate through the food chain, especially in the flesh of filter-feeder organisms, HABs impact on other organisms (incl. humans), and may be very harmful when toxins involved are paralytic, amnesic, or diarrheic shellfish poisoning.

Secondary production is achieved by zooplankton in the pelagic domain, and filter-feeding and grazing organisms in the benthos that transform the primary production into organic matter, which is then available to higher trophic levels.

Measurement approaches

There are three major categories of measurements related to this indicator: Primary production: quantity (biomass) and quality (e.g., HABs); Secondary production (e.g., zooplankton, invertebrates);
Reproduction parameters: i.e., measuring life history stage (in relation to genetic diversity measurements; indicator E1), reproduction success (e.g., fecundity, maturity, sex ratio), survivorship (e.g., spawning survival rates), longevity (e.g., mean generation time of populations).

Limitations of the indicator

When using such indicators for management purposes, it is important to keep in mind that most of these measurements are actually indirect measures and proxies to assess marine productivity. Also, it should be stressed that both production and reproduction are natural processes that cannot be managed directly. Therefore, ICOM should not use management objectives based on these indicators and types of measurements (e.g., primary production, spawning survival rates) when implementing an ecosystem approach to management (DFO, 2004). The management of activities that may have impacts on these ecosystem properties and processes, in turn, will hopefully result in maintaining these key ecosystem properties.

Status of the methodology

—

Alternative definitions

—

E4 Production and reproduction

Assessment data

Data needed to compile the indicator

Various types of data are needed, such as on:

- Phytoplankton and benthic plants and algae (primary production); the occurrence, frequency, intensity and duration of catastrophic events such as red-tides or HABs in the ICOM area over time;
- Zooplankton and benthic invertebrates (secondary production);
- Species and populations in higher trophic levels (reproduction parameters).

Data sources and collection methods

As a result of progress in development of remote sensing and satellite imagery technologies, chlorophyll-a and surface water color are the standard surrogate for assessing primary productivity in marine and coastal surface waters. Chlorophyll-a and water color maps produced from satellite imagery are increasingly available worldwide while data management networks and global observing systems like GOOS are being developed and are now accessed by an increasing number of users and stakeholders involved in ICOM initiatives.

For HABs, monitoring and surveys programmes should be set up in all coastal areas since the potential for HABs is found everywhere, with an increase in occurrences of blooms and closures of impacted areas (shellfish beds, aquaculture sites) worldwide (GESAMP, 2001a).

Analysis and interpretation of data

Simultaneously measuring primary and secondary production gives the data to assess the efficiency of energy transfer between lower trophic levels, providing an indication about ecosystem structure and functioning, and biological relationships (indicator E5).

Reporting scale and output

The reporting scale for this indicator varies greatly since it has to capture biological units (species and populations) and functions (production and reproduction), and should be scaled within a spatial framework, i.e., distinction between pelagic and benthic domains, or based on large-scale biological patterns (Powles et al., 2004).

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (quantitative data), figures and graphs (histograms, comparisons of sites or periods, trends), maps (e.g., primary production patterns), images (satellite imagery providing seawater color and chlorophyll-a content). Ecological Indicators reports should be regularly updated to capture environmental changes, impacts of activities as well as progress done (evaluation of the ICOM effectiveness) and fill knowledge gaps.

E4 Production and reproduction

Additional information

Organizations and programmes involved in the development of the indicator

- Environmental Indicators for National State of the Environment Reporting. Australia: State of the Environment. See the Environmental Indicator Report on Estuaries and the Sea (1998), 80 p;
- European Environment Agency (EEA) Environmental Signals. A series of reports published since 2000, e.g., Benchmarking the Millennium (2002), Chapters on Fisheries, Inland and Coastal Waters. See also the EEA Signals 2004: An EEA update on selected issues;
- Fifth International Conference on the Protection of the North Sea. (Bergen Declaration, 2002). See ECOQOs framework proposed to the North Sea pilot project;
- GOOS-COOP;
- Health, Ecological and Economic Dimensions (HEED) of the Global Change Programme, e.g., Marine ecosystems: Emerging diseases as indicators of change– Year of the Oceans Special Report (1998), 78 p;
- H. John Heinz III Center, e.g., The State of the Nation's Ecosystems (2002), chapter on Coasts and Oceans;
- Intergovernmental Oceanographic Commission- UN Educational, Scientific and Cultural Organization (IOC-UNESCO), e.g., A reference guide on the use of indicators for integrated coastal management (2003). IOC in collaboration with DFO, CSMP and NOAA. Manuals and Guides 45, ICAM Dossier no.1, 127 p;
- ICES, e.g., proposed framework for monitoring the status of ecosystem components. ICES Advisory Committee on Ecosystems (2004);
- GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO /WHO/IAEA/UN/UNEP;
- OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. See the Quality Status Report series.

References

DFO (2004). *Habitat Status Report on Ecosystem Objectives*. Department of Fisheries and Oceans (Canada) – Canadian Science Advisory Secretariat (CSAS), Habitat Status Report No. 2004/001. 11 p. (report available at: www.dfo-mpo.gc.ca/csas/);

GESAMP (2001a). *A Sea of Troubles*. GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO/WHO/IAEA/UN/UNEP, Reports and Studies No. 70, 35 p;

Powles, H., Vendette, V., Siron, R. and O'Boyle, R. (2004). Proceedings of the Canadian Marine Ecoregions Workshop, Ottawa, March 23-25, 2004. Department of Fisheries and Oceans (Canada), Canadian Science Advisory Secretariat (CSAS) Proceedings Series No. 2004/016, 47 p. (report available at: www.dfo-mpo.gc.ca/csas/).

Internet links

CBD: http://www.biodiv.org/default.shtml
EEA: http://eea.europa.eu/
John Heinz Center: http://www.heinzctr.org
GOOS: http://ioc.unesco.org/goos/
ICES: http://www.ices.dk/indexfla.asp
IOC-UNESCO: http://ioc.unesco.org
OSPAR: http://www.ospar.org

E5 Trophic interactions

Nature of indicator

Definition
Trophic interactions essentially refer to the trophic links (e.g., predators-prey) between all organisms in the ecosystem, whereas the trophic structure is the way the architecture of the marine food web (trophic chains) is designed. Trophic interactions are essential in maintaining the structure and function of the ecosystem, as well as ecosystem properties such as productivity and resilience.

Unit of measurement
Species (individuals and populations) and community levels.

Relevance

Purpose
Trophic interactions are a key component of overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of the vigor of the ecosystem. This assessment is needed to ensure that the management objective of maintaining the ecosystem function is met.

International conventions, agreements and targets
FAO Code of Conduct (1995)

Methodological description

Underlying definitions and concepts
Trophic structure and interactions can be characterized by the number of trophic levels in selected marine food webs (prey level, predator-1 level, predator-2 level, etc.) and number of key species in each of these trophic levels (number of prey species, number of predator-1 species, number of predator-2 species, etc.).

Measurement approaches
There are four categories of measurements related to this indicator: Complexity of food web (trophic levels and interactions between and within); Key predator-prey relationships; Keystone species; Size spectra (i.e., number of individuals at given weight or length).

Limitations of the indicator
Although this indicator is theoretically useful for capturing overall ecosystem structure and function, measurements will likely be difficult to achieve (complexity of marine food web) or to be used in ecological assessments, in terms of significance and reliability of results. This indicator monitors ecosystem properties that are not directly under management control. That means that the result and effectiveness of management actions for maintaining trophic interactions in the ICOM area will be observed indirectly, probably after a long enough period of time that will depend on the complexity of interactions, importance of impacts (e.g., by fishing) and resilience of the ecosystem. On the other hand, if an activity has an impact on the trophic structure and interactions (e.g., over-fishing of forage species, introduction of exotic species), there would probably be a time lag before this indicator shows significant changes to alert managers.

Status of the methodology
—

Alternative definitions
—

E5 Trophic interactions

Assessment of data

Data needed to compile the indicator

In order to assess the complexity of the food web, measurement will have to capture species interactions within and between trophic levels. To achieve this, measurements will have to be diversified, focusing on key groups of species that are representative of the food web and ecosystem structure, such as predators, their prey, and mid-trophic levels like forage species, e.g., the presence and abundance of top predators, identification of forage species, size spectra in each trophic level, inventory of dominant species in given biological communities, average weight and average/maximum length of the fish community (incl. the proportion of large fish), abundance of alternate preys for a given species of importance, predator-induced mortality rates on key prey populations, biomass of key dependant predators for a given prey species, diet composition (e.g., index of diet complexity) of species of interests (e.g., species at risk, marine mammals), etc.

Data sources and collection methods

Fish communities, mainly commercial fish stocks, are among the most investigated components of marine and coastal ecosystems. Because of socioeconomic reasons, monitoring and stock assessments for fisheries management purposes have produced long-term and continuous series of data. With the increasing interest for conservation (e.g., species at risk, marine protected areas), one can also expect to get information on non-commercial species and their trophic interactions with other ecosystem components.

Analysis and interpretation of data

—

Reporting scale and output

Measurements and use of this indicator should be done at large spatial scales (i.e., probably at the management area scale or even larger) to ensure that all trophic interactions within the food web are captured and processes such as populations dynamics are likely to dominate over extrinsic (finer scale) factors like migration (DFO, 2004).

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (quantitative data), figures and graphs (flow chart figures), models (functional model of the ecosystem, conceptual model of the food web). Ecological Indicators reports should be regularly updated to capture environmental changes, impacts of activities, as well as progress made (evaluation of the ICOM effectiveness) and fill knowledge gaps.

Additional information

Organizations and programmes involved in the development of the indicator

- Fifth International Conference on the Protection of the North Sea. (Bergen Declaration, 2002). See ECOQOs framework proposed to the North Sea pilot project;
- FAO, e.g., Fisheries Management – 2. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries, 4, Suppl. 2, Rome (2003), 112 p;
- ICES, e.g., Proposed framework for monitoring the status of ecosystem components. ICES Advisory Committee on Ecosystems 2004 Report.

References

DFO (2004). *Habitat Status Report on Ecosystem Objectives*. Department of Fisheries and Oceans (Canada) – Canadian Science Advisory Secretariat (CSAS), Habitat Status Report No. 2004/001. 11 p. (report available at: www.dfo-mpo.gc.ca/csas/).

Internet links

—

E6 Mortality

Nature of indicator

Definition

Mortality of marine organisms that results in a decrease in numbers of individuals or in the biomass of populations. In extreme cases, massive mortalities may lead to the depletion of entire populations and place these species at risk of extinction (see also Indicator E7).

Unit of measurement

Measurements at the species/population level.

Relevance

Purpose

Mortality is a key component of overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of the vigor of the ecosystem. This assessment is needed to ensure that the management objective of maintaining the ecosystem function is met.

International conventions, agreements and targets

CBD (1992) – UNEP; FAO Code of Conduct (1995); Reykjavick Declaration on Responsible Fisheries in the Marine Ecosystem (2001); Agreement on the Convention and Management of Straddling Fish Stocks and Highly Migratory Fish Stocks, UNFA (UNCLOS, 1995); International High Seas Task Force to address Illegal, Unreported and Unregulated (IUU) fishing on the high seas (OECD, 2003).

Methodological description

Underlying definitions and concepts

In the marine environment, mortality may be caused by natural predation, change in environmental conditions, harvesting or fishing. When the cause of mortality is unknown, usually it is called 'unusual mortality' (e.g., stranding of marine mammals; mass mortalities of fish), although in most cases, changes in environmental conditions, including poor water quality, are the likely cause, whereas mortality of non-target species caused by fishing (fishery by-catch) will be reported as "incidental mortality".

Measurement approaches

There are three categories of measurements related to this indicator: Fishing mortality; Incidental mortality (by-catch); Natural mortality (predation); Other causes (incl. unknown and poor environmental conditions).

Limitations of the indicator

In contrast to fishing mortality, which has been well documented for obvious reasons, very little is known on the other categories of mortality, which will likely be a weakness in using this indicator.

Status of the methodology

—

Alternative definitions

—

E6 Mortality

Assessment of data

Data needed to compile the indicator

Statistics of major commercial fish and shellfish species, as well as of recreational fishing where it is an important activity, will be needed, e.g., quantity of target species landed expressed in market value or volume (e.g., tones/year), size spectra (i.e., numbers of fish at length/weight in catch) and/or age-length relationships. Also, parameters used for fisheries management (e.g., Maximum Sustainable Yield, fleet capacity, types of gears) will be good surrogates for assessing fishing mortality (see socioeconomic indicators). In addition, it would be wise to collect data on by-catch and discards to assess impacts of local fishing practices on ecosystem productivity (E4) and water quality (E8).

Unusual mortalities can be good indicators of overall ecosystem health. The assessment of unusual mortalities should include species affected, number and frequency of events, number of individuals involved per event, whether they are species at risk, etc.

Data sources and collection methods

Monitoring this indicator should focus on species harvested by commercial and recreational fishing, as well as non-target species frequently caught, forage species and species of interest (keystone species, species at risk). Fisheries-related data may come from "at sea" surveys and landing records. In the absence of any monitoring data to support fishery science and stock assessments, landings (in terms of volume or value) and fishing efforts (e.g., number of vessels, types and number of nets, gear, etc.) may be a useful proxy to assess the quantity of resources harvested in the management area and in turn, the fishing mortality; it may be an indication, although indirect, of the status of local fisheries and fish stocks. Mortality measurements will be also useful to assess the reproductive status and success of populations (Indicator E5), e.g., by calculating species size spectra, age/size structure of populations, age at maturity, early-life history survival rate, spawning biomass, mortality rate, etc. Both mortality and reproduction indicators have close enough measurements and data should be therefore collected and interpreted in an integrated assessment context.

Analysis and interpretation of data

This indicator should be monitored in parallel with the other biological indicators involving common (or complementary) measurements on ecosystem structure and function - diversity (E1), distribution (E2) and abundance (E3) and trophic interactions (E5) - because any change in mortality patterns, whatever the cause, will have a direct impact on these properties. In this respect, it will be important to consider this set of biological indicators within an integrated assessment framework, to address inherent uncertainties and science gaps on biological interactions and ecosystem processes, and inform ICOM based on the best science. This integration of measurements and indicators will be particularly critical in management areas where fishing is one of the most important activities.

Unusual mortalities or high frequency of incidental mortalities may be an indication of the degradation of marine environmental quality.

Reporting scale and output

The reporting scale for this indicator will greatly vary and depends on the aspect that is to be considered. The reporting scale will be adjusted to the distribution area of the population for which the fishing mortality is to be assessed, or the distribution area of a given species or populations when incidental or unusual mortalities are the issues. When causes of mortality are unknown or when poor environmental quality is suspected (Indicators E7 and E8), the reporting scale should be as large as possible to capture complex processes involved (contaminants, climate change, habitat degradation, etc.)

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (quantitative data), figures and graphs (histograms, comparisons of sites or periods, statistics and trends), models (for refining predictions). Ecological Indicators reports should be regularly updated to capture environmental changes, impacts of activities, as well as progress made (evaluation of the ICOM effectiveness) and fill knowledge gaps.

E6 Mortality

Additional information

Organizations and programmes involved in the development of the indicator

- Environmental Indicators for National State of the Environment Reporting. Australia: State of the Environment. See the Environmental Indicator Report on Estuaries and the Sea, (1998), 80 p;
- EEA Environmental Signals. A series of reports published since 2000, e.g., Benchmarking the Millennium (2002), Chapters on Fisheries and Inland and coastal waters. See also the EEA Signals 2004: An EEA update on selected issues;
- FAO, e.g., Fisheries Management – 2. The ecosystem approach to fisheries. FAO Technical Guidelines for Responsible Fisheries, 4, Suppl. 2, Rome, 2003, 112 p;
- Fifth International Conference on the Protection of the North Sea. (Bergen Declaration, 2002). See ECOQOs framework proposed to the North Sea pilot project;
- GOOS-COOP;
- H. John Heinz III Center, e.g., The State of the Nation's Ecosystems (2002)/chapter on Coasts and Oceans;
- IOC-UNESCO, e.g., A reference guide on the use of indicators for integrated coastal management (2003). IOC in collaboration with DFO, CSMP and NOAA. Manuals and Guides 45, ICAM Dossier no.1, 127 p;
- ICES, e.g., Proposed framework for monitoring the status of ecosystem components. ICES Advisory Committee on Ecosystems Report (2004);
- GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO /WHO/IAEA/UN/UNEP;
- OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. See the Quality Status Report series.

References

—

Internet links

CBD: http://www.biodiv.org/default.shtml
EEA: http://eea.europa.eu/
FAO: http://www.fao.org
John Heinz Center: http://www.heinzctr.org
GOOS: http://ioc.unesco.org/goos/
ICES: http://www.ices.dk/indexfla.asp
IOC-UNESCO: http://ioc.unesco.org
OSPAR: http://www.ospar.org

E7 Species health

Nature of indicator

Definition

A species is in good health when biological processes like feeding, reproduction, growth, behavior, etc. are not significantly affected and the population remains within the natural range of variability so that the species continues playing its natural role in the ecosystem.

Unit of measurement

Species is the basic unit for this indicator. All basic measurements will be conducted at the species level; e.g., representative species, test species, sentinel species, exposed species, species of concern, etc. However, another approach for assessing species health is to use laboratory micro-scale bio-monitoring and bio-testing, which may consider the sub-species level (i.e., tests conducted at the cellular level).

Relevance

Purpose

The species health is a key component of the overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of marine environmental quality. This assessment is needed to ensure that the management objective of maintaining physical and chemical properties of the ecosystem is met.

International conventions, agreements and targets

CBD (1992) – UNEP.

E7 Species health

Methodological description

Underlying definitions and concepts

Micro-scale toxicity bio-tests (micro-biotests). These are based on the response of a variety of indicator species (unicellular or young life stages of multi-cellular species) sensitive to certain groups of toxic chemicals and kept in controlled conditions; the test medium (sample) may be water or sediment and test species may be bacteria (e.g., Microtox© test), macroalgal cysts, microalgae in cultures, invertebrates (e.g., Daphnia test, rotifers), marine crustaceans, larvae and embryos (fish species), etc.

Bio-marker assays. Many types of bio-marker assays have been developed, e.g., biomarkers of general biological distress (e.g., cardiac activity in molluscs), behavioral bioassays (e.g., swimming behavior in Mysids), and chemical bio-markers to detect the presence of –or assess the exposure to– various types of pollutants, e.g., fluorescence assays (PAHs), Imposex in certain species (Endocrine Disruptors, TBT), Cytochrome P-450 (oil hydrocarbons, PAHs),Protein assay/metallothionein (heavy metals), Cholinesterase inhibition assay (Pesticides), micronuclei assay (genotoxins). These biomarkers should be monitored in sentinel species, in exposed species living in contaminated environments, in sensitive species, species at risk, etc.

Measurement approaches

There are four categories of measurements related to this indicator: Species at-risk of extinction;
Bioaccumulation of toxic compounds (incl. use of biotests and biomarkers); Diseases and abnormalities (incl. pathogen bacteria, viruses and parasites); Seafood quality.

Biomass removal by fishing, habitat degradation and presence of contaminants from numerous sources are among the most important threats on species health and biodiversity. In this respect, the worst scenarios, i.e., over fishing and stocks depletion, habitat losses, bioaccumulation of toxic compounds and occurrence of diseases and abnormalities have been already observed worldwide (GESAMP, 2001a). The aim of this broad indicator is to capture these stressors through this series of measurements. However, these measurements should be fully integrated (in terms of monitoring and data interpretation) to make the indicator reliable and useful to management. For example, in parallel with in-situ observations and measurements, micro-scale toxicity tests may be particularly pertinent to ICOM in developing countries because commercial kits have been developed and standardized with the aim of providing simple procedures (i.e., relatively easy to run even without strong science support or equipment)- portable kits, low cost, practical, repetitive (i.e., allowing self-training) and fast-reading. On the other hand, when very little is known about the degree of contamination of the management area, the best use of bio-markers is as screening techniques for preliminary assessment, using a battery of assays as an integral part of field monitoring, i.e., the Rapid Assessment of Marine Pollution (RAMP) approach.

Limitations of the indicator

When and where the contamination of the biota and seafood is an issue, the monitoring strategy will have to carefully select sentinel species that are well known in terms of their biology and ecology, exposed to contaminants of concern, not too sensitive to be able to survive in contaminated waters, well distributed in the management area and representative of the local biota (e.g., UNEP-led "Mussel Watch" programme, which has been extensively used for assessing the marine environmental quality worldwide). Furthermore, it will not be easy to monitor and sample species at risk, although non-destructive techniques may be developed.

Although they are based on promising approaches, existing bio-monitoring and bio-testing tools have to be conducted under standardized laboratory conditions and are sensitive to only certain categories of toxins that are not necessarily representative of the actual environmental conditions in the study area. Managers must keep in mind that results from laboratory tests are not very meaningful by themselves and should be validated by field data or in-situ observations to be reliable and useable in a management context.

Status of the methodology

For the use and relevance of toxicity micro-biotests, see the review by Wells (1999). For the use of bio-marker assays within a management context, see the RAMP approach (Depledge and Bowen, in progress).

Alternative definitions

—

E7 Species health

Assessment of data

Data needed to compile the indicator

The complementary use of toxicity tests and biomarker assays with measurements of contaminant levels in the environment (Indicators E8 and E9) would give a direct indication of actual damages caused by contaminants at the species level and how they affect, or could ultimately affect, the entire ecosystem.

In addition to reporting on the exposure of biota to toxic compounds (bio-marker assays), quantifying the degree of contamination (concentrations of contaminants), and assessing their toxicity (toxicity tests), the collection of data on marine diseases and abnormalities, incl. biological vectors like pathogens, viruses and parasites (HEED, 1998) would provide useful information to confirm the threats and impacts on species health and their consumers, the top predators, and ultimately make linkages with human health, particularly in heavily polluted areas (Indicators E8 and E9).

Data sources and collection methods

Seafood quality is affected by contaminants accumulated in animal tissues, e.g., heavy metals and Persistent Organic Pollutants (POPs), but it is impossible to monitor all the species and all the chemicals that are released into the marine environment, even in limited areas. The monitoring strategy around this indicator will therefore have to focus on toxic chemicals which are: (i) present in high concentrations in the study area; (ii) known to be bio-accumulated in food chains; (iii) of global/national and regional concerns. Also, the selection of indicator species will be of critical importance. When/where seafood quality is an issue, these sentinel species should be first selected from commercial and recreational fish species, in fish and shellfish groups. Other species, however, like certain non-commercial sediment-dwelling organisms or filter-feeders at mid-trophic levels (forage organisms) are an important source of food for higher levels. Measuring their condition is a good indication of the quality of the environment in which they live and would help predict the importance of bioaccumulation through local food chains. In this respect, top predators such as fish, marine mammals and seabirds (and their eggs) are likely the best sentinel species, although they may be more difficult to sample and monitor.

Analysis and interpretation of data

The occurrence of species at risk, and a fortiori an increase in the number of species considered at risk under various listings (of concern, threatened, endangered, etc.) or in their spatial extent over time will reflect that the biodiversity of the ecosystem and its key functional units (species) are threatened.

In environmental assessments, micro-scale toxicity tests have been best used as laboratory tools conducted in complement with in-situ studies and measurements. They may provide useful information on the potential harm and probable effects of contaminants on marine biota. Bio-marker assays may be used for assessing the general environmental stress after measuring the actual distress and effects caused by the presence of contaminants in the marine environment. Chronic and acute effects measured by bio-markers may be diverse, reflecting, for example, immunological effects, dysfunctions or behavioral changes.

Reporting scale and output

Scale is dependent on the species health measurement; for example, reporting on species at risk will require that their distribution areas and habitats are captured; reporting on contaminants may vary from very local "hot spots" to large contaminated areas; reporting on seafood quality would be at the appropriate scale where seafood is harvested (e.g., shellfish beds, fishing areas); and marine diseases may be disseminated over large regions of oceans, with impacts observed at the ecosystem-scale (HEED, 1998).

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (e.g., quantitative data from biomarkers), figures and graphs (histograms for reporting on bio-tests, comparisons of sites or periods for seafood quality, trends), maps (e.g., reporting on species at risk, diseases occurrence), models (e.g., modeling the bioaccumulation through food chains). Ecological Indicators reports should be regularly updated to capture environmental changes, impacts of activities, as well as progress done (evaluation of the ICOM effectiveness) and fill knowledge gaps.

E7 Species health

Additional information

Organizations and programmes involved in the development of the indicator

- Environmental Indicators for National State of the Environment Reporting. Australia: State of the Environment. See the Environmental Indicator Report on Estuaries and the Sea (1998), 80 p;
- Fifth International Conference on the Protection of the North Sea. (Bergen Declaration, 2002). See ECOQOs framework proposed to the North Sea pilot project.
- GOOS-COOP;
- H. John Heinz III Center, e.g., The State of the Nation's Ecosystems (2002)/chapter on Coasts and Oceans;
- IOC-UNESCO, e.g., A reference guide on the use of indicators for integrated coastal management (2003). IOC in collaboration with DFO, CSMP and NOAA. Manuals and Guides 45, ICAM Dossier no.1, 127 p;
- ICES, e.g., Proposed framework for monitoring the status of ecosystem components. ICES Advisory Committee on Ecosystems Report (2004);
- GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO /WHO/IAEA/UN/UNEP;
- OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. See the Quality Status Report series.
- RAMP programme (UNEP).

References

Depledge, M. and Bowen, R. (in progress). Rapid Assessment of Marine Pollution and the Mitigation of Public Health Risk.

GESAMP (2001a). A Sea of Troubles. GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO/WHO/IAEA/UN/UNEP, Reports and Studies No. 70, 35 p.

HEED (1998). Marine ecosystems: Emerging diseases as indicators of change. HEED – Year of the Oceans Special Report, 78 p.

Wells, P.G. (1999). Biomonitoring the health of coastal marine ecosystems – The roles and challenges of micro-scale toxicity tests. Marine Pollution Bulletin, 39: 39-47.

Internet links

CBD: http://www.biodiv.org/default.shtml
John Heinz Center: http://www.heinzctr.org
GOOS: http://ioc.unesco.org/goos/
ICES: http://www.ices.dk/indexfla.asp
IOC-UNESCO: http://ioc.unesco.org
OSPAR: http://www.ospar.org

E8 Water quality

Nature of indicator

Definition

This indicator describes the physical-chemical and oceanographic properties of the water column and assess seawater quality in terms of its ability to sustain marine life and biological processes.

Unit of measurement

Measurements involved in this indicator are essentially physical-chemical types of measurements. Basic oceanographic measurements are surface seawater temperature (SST), salinity and concentrations of suspended matter (or surrogates such as turbidity or surface water color). In addition to these basic oceanographic data, measurements of levels of nutrients and dissolved oxygen (eutrophication parameters), as well as concentrations of contaminants will provide a good indication of the degree of pollution of the water column. The major groups of contaminants of concern worldwide are: heavy metals, POPs, hydrocarbons, organo-tins, waste and debris. Even marine debris is not just aesthetics; marine species may be entangled or strangled by plastic bags, fish nets or polystyrene foam pellets.

Relevance

Purpose

The water quality is a key component of overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of marine environmental quality. This assessment is needed to ensure that the management objective of maintaining physical and chemical properties of the ecosystem is met.

International conventions, agreements and targets

CBD (1992) – UNEP; Stockholm Convention on Persistent Organic Pollutants (2001). The list of banned POPs contains a dozen very toxic substances, which have accumulated in the marine environment worldwide like pesticides, PCBs, dioxins and furans

E8 Water quality

Methodological description

Underlying definitions and concepts

Physical oceanographic features and processes strongly influence marine biology, as well as ecosystem structure and function (Field et al., 2002). For example, species distribution (Indicator E2) is primarily based on the optimum range of water temperature and salinity. The abundance of plankton species (Indicator E3) and primary and secondary productions (Indicator E4) is driven by currents, light availability, nutrients, etc. Biological processes like reproduction (Indicator E4) and biological interactions (Indicator E5) also need specific oceanographic conditions (e.g., current velocity, turbulence and mixing processes) and/or chemical properties of seawater within bounds of natural variability (dissolved oxygen, nutrients, etc.) to occur at appropriate spatial and temporal scales. Fisheries management also needs these basic measurements for conducting fish stock assessments (Indicator E6). Oceanographic processes occur at ecosystem-scale and can help assess the diversity of ecosystems (Indicator E1). This information is also needed to report on the state of the oceans and the natural variability, in addition to better understanding of and addressing complex environmental issues such as the decline of water or habitat quality (E8 and E9).

Marine pollution and contaminants. Historically, concern about the health of the oceans has been generated by pollution. Even nowadays, the presence of contaminants in the marine environment is one of the most important environmental issues that almost all coastal regions in the world are facing (GESAMP, 2001a). This is also true for those regions and countries that are not as industrialized as developed countries. These contaminants usually come from point-source discharges (e.g., sewage outfalls) as well as diffuse sources of contamination, mainly from land-based activities and shipping. Shipping is one of the most rapidly increasing activities worldwide and accidents may lead to various types and degrees of impacts in coastal/oceans waters (GESAMP, 2001a). They may be assessed by recording the frequency of events (e.g., oil spills), type, amount and toxicity of cargo released, the number of species or individuals affected (e.g., oiled birds), the importance of coastal impacts (e.g., length of shoreline impacted by an oil spill), occurrence at sea (oil slicks, tarballs, floating debris), etc. When/where marine debris and solid waste are an issue, it may be useful to conduct systematic surveys at sea and/or observations on shore, to record their occurrence and amount (or volume) of each category (i.e., type, or origin, of debris) in "sampling" areas, in order to assess the importance of such materials and species and habitats which are the potentially affected, depending on the nature of such debris.

Eutrophication. Algal and plants need nutrients for growing and producing primary biomass; they have a key role in ecosystem function. Excess nutrients (eutrophication) usually stimulate micro-algal growth (initial phase), and the resulting increase in production of organic matter in turn enhances biodegradation with an increase in oxygen consumption.

Biological vectors of diseases. Measurement/assessment of discharges, levels and prevalence of faecal bacteria, parasites, pathogens and other disease agents will give a good indication of water quality and associated risks to human health through recreational activities or seafood consumption.

E8 Water quality

Methodological description

Measurement approaches

There are five categories of measurements related to this indicator: Water column properties; Oceanographic processes, variability and regime shifts; Sedimentation (e.g., transport of suspended sediments); Pollutants and contaminants; Eutrophication parameters.

Limitations of the indicator

Observing and interpreting regime shifts will require good knowledge and a strong science support (equipment, at-sea facilities, expertise) and the monitoring of complex oceanographic processes (e.g., currents and water masses, sedimentation). Furthermore, it may be very difficult to assess and distinguish the natural variability of oceanographic properties from changes caused by human impacts, including climate change and cumulative impacts. Once they are discharged at sea, contaminants may be found in a variety of forms that will influence their transport and fate in the marine environment, e.g., dissolved components, or transported as adsorbed onto suspended particles –either organic matter or mineral. If they remain in the water column, they will be disseminated, sometimes over large areas, by currents and turbulence and will be difficult to monitor. Coastal waters may be either impacted by direct discharges, or by land-based activities that might be far from the coastal management area (e.g., after transport by atmospheric processes, rivers and watersheds, currents, etc.). Coastal waters may also trap certain pollutants, and processes involved in pathways and behavior of contaminants (e.g., adsorption, sedimentation, bioaccumulation) may be complex, dependent on environmental conditions and therefore difficult to capture at large scales. Assessing contaminant levels in water bodies needs the support of well-structured science monitoring programmes and facilities/analytical capacity to provide meaningful measurements and reliable data on these chemical indicators. When monitoring toxic chemicals (e.g., heavy metals, POPs), it is important to understand well the environmental chemistry of such compounds, i.e., their fate and effects after they are introduced into the marine environment. For example, certain forms of heavy metals are more reactive – and more toxic – than others; certain chemical forms like organo-metals, for example, may be more easily bio-accumulated than the "parent" or precursor compounds (e.g., mercury/methyl-mercury).

Status of the methodology

—

Alternative definitions

—

E8 Water quality

Assessment of data

Data needed to compile the indicator

A wide variety of data is needed to monitor this indicator and asses overall water quality; these data are physical oceanography data (e.g., temperature, turbidity), chemical data (e.g., nutrients, contaminants) and biological data (e.g., bacteria and parasites).

Data sources and collection methods

—

Analysis and interpretation of data

Key oceanographic variables are essential to characterize different water masses and currents, and to track freshwater inputs (e.g., river plumes). These water properties are also influenced by regime shifts induced by, for example, climate change. Concentration of total suspended matter and light attenuation (e.g., using the Secchi disk technique) are the simplest ways for measuring water turbidity, in relation to available sunlight, which is necessary for primary production (Indicator E4). These variables are strongly affected by both natural processes (e.g., transport of sediments, algal blooms) and human activities (e.g., resuspension of sediments due to bottom disturbance, coastal development, dredging).

Although *eutrophication parameters and contaminants* may also characterize different water masses (e.g., river discharges), they are mainly used to assess the degree of pollution and track the influence of land-based activities. Dissolved oxygen (expressed in mg/litre or percent saturation level) is a key chemical component that supports marine life and aerobic processes associated with degradation of organic matter. Dissolved oxygen level is also a key indicator that measures the natural physical-chemical properties of the ecosystem. However, like nutrients, when organic matter (e.g., dead organisms, sewage, organic contaminants) is in excess in seawater or sediments, aerobic degradation is stimulated and results in an increase in oxygen consumption. Oxygen depletion (areas of hypoxia) may locally occur with decline in the overall environmental quality and drastic impacts on biota (e.g., mass mortalities of sessile species (Indicator E6) or displacement of mobile species (E7).

High concentrations of pollutants show that coastal water quality has been degraded, with direct consequences on the health of organisms living in this water body (see Indicator E7). Contaminated particles/sediments dispersed into the water column contribute to the decline of the overall quality of the marine environment (Indicator E9). The sources of contamination in sediments, as well as the processes involved, may be very diverse depending on the chemical reactivity and affinity of contaminants to sediments (e.g., mineral particles, high content of organic matter, grain size, etc.). Some local activities such as dredging, dumping or trawling cause direct physical disturbance of the sediment and may cause re-suspension of contaminated sediments. High concentration of bacteria that originate from sewage (e.g., E. coli) is an early warning that swimming or shellfish harvesting are unsafe activities and should be prohibited until the concentration decrease below a certain threshold as predefined by management or regulatory bodies. However, most pathogens and diseases vectors are not yet well known in the marine environment (HEED, 1998). Although systematic surveys may be set up to monitor certain events such as HABs (Indicator E4), these may still be very difficult to predict and control.

E8 Water quality

Assessment of data

Reporting scale and output

Scale will greatly depend on the type of measurement for this indicator.

Basic oceanography data: Should be reported at large scales (i.e., management area or larger). Because these data are usually collected and recorded everywhere and over a longer time period, they can be used to track large-scale processes (e.g., long range transport of sediments and contaminants) and long-term changes (regime shifts, climate change).

Contaminants: May be reported at scales smaller than the management area (e.g., to identify hot spots of contamination within the management area). If no hot spots have been reported in the management area, monitoring of contaminants should be conducted and reported over the whole management area, as a first screening to further assess the degree of contamination and eventually identify the most polluted areas.

Eutrophication parameters: May be reported at finer scales because sources of excess loads of nutrients and hypoxia areas (oxygen depletion) are usually localized and relatively easy to identify at small scales.

Sedimentation data: Should be collected at large scales to ensure that sedimentation processes such as coastal transport of sediments are captured. However, in some cases, finer scale reporting may be useful, e.g., to refine the knowledge on local processes (e.g., area of high sedimentation) or re-suspension of surface sediments.

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (quantitative data), figures and graphs (e.g., histograms for reporting on contaminants, comparisons of sites or periods, trends), maps (oceanographic variables, contaminated areas, etc.), models and animations (predictions of physical oceanographic variables, analysis of historical data series and assessment of the natural variability, scenarios for regime shifts), images (e.g., aerial photographs showing freshwater plumes in coastal zones) and satellite imagery (SST maps, seawater color as a proxy of turbidity of surface waters). Ecological Indicators reports should be regularly updated to capture environmental changes, impacts of activities, as well as progress made (evaluation of the ICOM effectiveness) and fill knowledge gaps.

E8 Water quality

Additional information

Organizations and programmes involved in the development of the indicator

- EEA Environmental Signals. A series of reports published since 2000, e.g., Benchmarking the Millennium (2002), Chapters on Fisheries and Inland and coastal waters. See also the EEA Signals 2004: An EEA update on selected issues;
- Environmental Indicators for National State of the Environment Reporting. Australia: State of the Environment. See the Environmental Indicator Report on Estuaries and the Sea (1998), 80 p;
- Fifth International Conference on the Protection of the North Sea. (Bergen Declaration, 2002). See ECOQOs framework proposed to the North Sea pilot project;
- GOOS-COOP;
- HEED;
- H. John Heinz III Center, e.g., The State of the Nation's Ecosystems / chapter on Coasts and Oceans (2002);
- IOC-UNESCO, e.g., A reference guide on the use of indicators for integrated coastal management (2003). IOC in collaboration with DFO, CSMP and NOAA. Manuals and Guides 45, ICAM Dossier no.1, 127 p;
- ICES, e.g., Proposed framework for monitoring the status of ecosystem components. ICES Advisory Committee on Ecosystems Report (2004);
- GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO /WHO/IAEA/UN/UNEP;
- OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. See the Quality Status Report series.

References

Field, J.G., Hempel, G. and Summerhayes, C.P. (2002). *Oceans 2020 – Science, Trends, and the Challenge of Sustainability*. Island Press, Washington, DC, 369 p.

GESAMP (2001a). *A Sea of Troubles*. GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO/WHO/IAEA/UN/UNEP, Reports and Studies No. 70, 35 p.

HEED (1998). Marine ecosystems: Emerging diseases as indicators of change. HEED- *Year of the Oceans Special Report*, 1998, 78 p.

Marvin, C., Grapentine, L. and Painter, S. (2004). Application of a sediment quality index to the lower Laurentian Great Lakes. *Environmental Monitoring and Assessment*, 91: 1-16.

Internet links

CBD: http://www.biodiv.org/default.shtml
EEA: http://eea.europa.eu/
John Heinz Center: http://www.heinzctr.org
GOOS: http://ioc.unesco.org/goos/
ICES: http://www.ices.dk/indexfla.asp
IOC-UNESCO: http://ioc.unesco.org
OSPAR: http://www.ospar.org

E9 Habitat quality

Nature of indicator

Definition
This indicator is to describe the different types of habitats and assess their quality to provide marine life with biological and physical features that are necessary for supporting life processes.

Unit of measurement
Habitat quality measurements help identify and quantify habitat types (number and extent, percent coverage), spatial patterns of key habitats (diversity at the ecosystem-level). Such measurements will be helpful to first review the current status of coastal habitats in terms of natural versus disturbed habitats, in addition to marine protected areas (incl., marine reserves, sanctuaries, conservation areas, national heritage areas, etc.).

Because a great variety of marine organisms are benthic and live directly on the surface sediment or are filter-feeders, the monitoring strategy should include the selection of indicator species as "sentinel" species (See Indicator E7), in addition to direct measurements of contaminants in sediment samples. The major groups of contaminants of concern worldwide are: heavy metals, POPs, hydrocarbons, organo-tins, waste and debris.

Relevance

Purpose
Habitat quality is a key component of overall marine ecosystem health. Monitoring this indicator will contribute to the assessment of marine environmental quality. This assessment is needed to ensure that the management objective of maintaining physical and chemical properties of the ecosystem is met.

International conventions, agreements and targets
CBD (1992) – UNEP

Methodological description

Underlying definitions and concepts
Surface sediment is a key structural ecosystem component that strongly influences the species distribution and diversity of benthic communities (benthic organisms are adapted to specific types of sediment) as well as the productivity of certain resources living in the benthos and, ultimately the overall benthic habitat quality. It is therefore very important to monitor natural properties (geological, physical and chemical properties) of surface sediments in coastal areas.

Sea level change is expected to be one of the most important impacts at the regional/local level; some countries or regions have already experienced trends that could be related to this issue.

Measurement approaches
There are five categories of measurements related to this indicator: Habitat types; Habitat alteration;
Sea level change; Landscape and bottomscape integrity; Sediment quality (natural properties and contaminants).

Limitations of the indicator
—

Status of the methodology
—

Alternative definitions
—

E9 Habitat quality

Assessment of data

Data needed to compile the indicator

Measurements should focus on ecologically significant areas (migration routes, spawning or nursery areas, etc.) and habitat types. This assessment is based on ecological considerations (e.g., inventory of the various types of habitats, in terms of structural and functional aspects), as well as on human influence (e.g., man-made habitats, protected, disturbed - lightly versus heavily – threatened, "at risk", etc.). In this respect, it would be useful to categorize "at risk" habitats into "high", "medium" and "low" risks, e.g., extent of coastline at risk of erosion, extent and impact of "seawalls", shoreline protection, industrial/urban areas.

For sediment contamination, the calculation of a Sediment Quality Index (Marvin et al., 2004) integrating and comparing scientific information (i.e., chemical data collected in-situ) and current management status (i.e., existing regulations and policies for controlling environmental quality) would be useful for reporting purposes.

Data sources and collection methods

Habitat types, habitat alteration and measurements of the landscape/bottomscape integrity will come mainly from field observations and will be a mixture of qualitative (narrative) and quantitative measurements. Sediment properties and quality may be more easily sampled and quantified. Ideally, sea level measurements should be based on historical records and trends (if data are available) and/or scenarios-based predictions (if there is a strong science support, i.e., models and experts are available).

Analysis and interpretation of data

Habitat type inventory and associated measures will help assess the habitat (ecosystem) diversity and impacts of human activities on habitats, and should give pertinent information to make sound linkages with spatial patterns and related issues (fragmentation, patchiness, connectivity), as well as impacting human activities.

Changes in sea level result from natural variability (e.g., geological process such as subduction) and the recently increase of sea level rise induced by climate change and global warming.

Sediment properties may be affected by a great variety of activities that cause direct physical disturbance (e.g., bottom trawling, mineral extraction, dredging) or indirect impacts (e.g., changes in flow regime, sediment transport and sedimentation process, which can occur after diverting freshwater, building coastal infrastructures, or degrading habitats). When the natural properties of sediments have been changed, the modified sediment may no longer sustain indigenous benthic communities; many benthic species will probably disappear and will be replaced by species that are able to adapt to new environmental conditions. Sediment quality may be also affected by contaminants that accumulate in surface sediments; in such a case, cumulative impacts may occur and must be taken into consideration in managing the impacting activities in the study area.

E9 Habitat quality

Assessment of data

Reporting scale and output

Overall, habitat and sediment quality needs to be assessed at scales as small as possible. Reporting on *habitat types and features* may be done at small scales if it is possible to conduct a detailed inventory of habitats in the management area. However, when this is not possible, habitats should be first classified into broad categories, with an initial screening covering all the management area, then refining the habitat classification and assessment in areas of particular interest for management purposes, e.g., areas of concern, area with ecological significance like spawning or breeding areas, area exposed to threats, areas disturbed by activities or restored, etc. *Sea level change* may be observed at very small scales but data should be reported and inserted into databases that are larger in scope than the management area, e.g., such data collected locally should be interpreted in the light of large-scale (regional and even global) trends.

Technical reports for ICOM purposes should contain a brief narrative on highlights and trends shown by the indicator. Supporting results from associated monitoring and measurements should be displayed in tables (quantitative data), figures and graphs (histograms, comparisons of sites or periods, statistics on habitats, trends), maps (for habitat types inventory, ecological patterns, etc.), images (e.g., aerial photographs to capture large scale disturbed habitat, erosion process, etc.), models (for sea level rise predictions, scenarios for assessing climate change impacts). Ecological Indicators reports should be regularly updated to capture environmental changes, impacts of activities as well as progress done (evaluation of the ICOM effectiveness) and fill knowledge gaps.

Additional information

Organizations and programmes involved in the development of the indicator

- EEA Environmental Signals. A series of reports published since 2000, e.g., Benchmarking the Millennium (2002), Chapters on Fisheries and Inland and coastal waters. See also the EEA Signals 2004: An EEA update on selected issues;
- Environmental Indicators for National State of the Environment Reporting. Australia: State of the Environment. See the Environmental Indicator Report on Estuaries and the Sea, 80 p. (1998);
- GOOS-COOP;
- H. John Heinz III Center, E.G., The State of the Nation's Ecosystems (2020) / chapter on Coasts and Oceans;
- IOC, e.g., A reference guide on the use of indicators for integrated coastal management (2003), IOC in collaboration with DFO, CSMP and NOAA. *Manuals and Guides 45*, ICAM Dossier no.1, 127 p;
- GESAMP and Advisory Committee on Protection of the Sea, IMO/FAO/IOC-UNESCO/WMO/WHO/IAEA/UN/UNEP;
- OSPAR Commission for the Protection of the Marine Environment of the North-East Atlantic. See the Quality Status Report series.

References

Marvin, C., Grapentine, L. and Painter, S. (2004). Application of a sediment quality index to the lower Laurentian Great Lakes. *Environmental Monitoring and Assessment*, 91: 1-16.

Internet links

CBD: http://www.biodiv.org/default.shtml
EEA: http://eea.europa.eu/
John Heinz Center: http://www.heinzctr.org
GOOS: http://ioc.unesco.org/goos/
ICES: http://www.ices.dk/indexfla.asp
IOC-UNESCO: http://ioc.unesco.org
OSPAR: http://www.ospar.org

Photo: © Yann Arthus-Bertrand

SE 1 Total economic value

Nature of indicator

Definition

Using neo-classical economic terms, these are the direct benefit values of products and services derived from the coastal and ocean management areas.

Relevance

The total economic value is likely the most important indicator of the importance of the coastal and management area to the region and its peoples. The focus of the indicator should be on those activities that distinguish the coastal and ocean area from other areas within the country or region. It allows comparisons at several levels, e.g., of national accounts to the total economy, between other national or regional geographic economic areas, as well as between countries.

Methodological description

Measurement approaches

To be most effective, the indicator should include all economic activities within the management area. While various classification or characterization schemes are possible, a useful generic "manner of construction" of the indicator is as follows:

1) *For the coastal zone (land-based activities dependent on the marine environment*):
   - Fish and seafood processing;
   - Tourism and recreation (local and visitors);
   - Port and shipping (people and goods) activities, including ship-building;
   - Other activities that are "water-dependent".

2) *For the marine environment (out to the boundary of the EEZ or the continental shelf):*

a) *Living resource exploitation*
   - Fishing (commercial, recreational, artisanal) activity;
   - Aquaculture and mariculture activity;
   - Pharmacological or genetic activity.

b) *Non-living resource exploitation*
   - Oil and gas industry;
   - Sand, gravel and mineral (e.g., salt) extraction.

c) *Non-consumptive use*
   - Electricity generation from wind, tidal or wave energy.

SE 1 Total economic value

Methodological description

Each sub-component above should ideally consider both the raw economic value and the value-added. A particularly important element with respect to value-added is the management and administration costs associated with the generation of the economic activity. Elements to be considered are as follows:

1) Local, regional, or national public costs, including:
   a) The cost of scientific research and advice;
   b) Management and administration costs of all government agencies associated with the economic activity;
   c) The cost (annual or amortized) of public infrastructure required for the facilitation of commerce (e.g., wharves and other public port facilities);
2) International or other donor costs or contributions;
3) Sectoral or other user charges or contributions;
4) The value of voluntary contributions, by citizens, non-governmental organizations, or industry.

Limitations

Total economic value can also incorporate "derived values", but caution is warranted in the use of these values, and their construction should be "methodologically rigorous". An example of a "derived value" is the value of using the marine environment for sewage or wastewater discharge in lieu of the investment required for treatment of these discharges. Similarly, "spin-off" economic values should be avoided. While any one or several subsets of the categories described above will provide very useful management information, anything less than total will not allow the full utility of the indicator to be achieved.

Assessment of data

Analysis and interpretation

Time series analysis; assessment of relative changes in economic/industrial structure; seasonal variation; comparisons between and among sector/uses; comparisons with non-coastal areas; comparisons between the coastal (on-shore; near-shore) and marine components (Territorial Sea; EEZ; continental shelf) of the management area.

Reporting scale

National, regional, local.

Output

Tables and maps accompanied by narrative reports.

Additional information

Data sources

Various sources on regional use and economic value associated with natural resources. Assessment methods can be derived from a broad array of sources, including: Turner, R.K. and Adger, W.N. (1995). *Coastal Zone Resources Assessment Guidelines*, LOICZ Reports and Studies, No. 4.

SE 2 Direct investment

Nature of indicator

Definition
The indicator is a description of the total direct investment associated with oceans and coastal activities in the ICOM management area.

Relevance

Total economic value, direct investment, and total employment are "companion indicators" and should typically be created, compiled and analysed together.

Methodological description

Measurement approaches
Direct investment should use the same "manner of construction" as that used for total economic value (see above).

The indicator should ideally classify investment by type. Two main categories are:

- Investment by Government (which may be sub-divided into investment by a national government and investment by sub-national or local governments);
- Private Sector Investment (which may be sub-divided into Business/Commercial investment, including where appropriate Multi-national Enterprises and investment by individuals.
- The indicator should also classify Foreign Direct Investment.

In all instances, this information should be collected for each sector or sub-sector according to the general sectoral/sub-sectoral classification used (i.e., for data collection for other indicators, such as total economic value, total employment or economic diversification).

Limitations
Caution should be used in any analysis concerning indirect investment, such as infrastructure of a general nature provided by government(s) that can be used for many purposes (e.g., highways and roads). It is more useful to focus data collection and analysis on direct investment related to coastal and oceans uses.

Assessment of data

Analysis and interpretation
Time series analysis; assessment of relative changes in economic/industrial structure; seasonal variation; comparisons between and among sectors/uses; comparisons with non-coastal areas; comparisons between the coastal (on-shore; near-shore) and the marine components (Territorial Sea; EEZ; continental shelf) of the management area.

Reporting scale
National, regional, local.

Output
Tables and maps accompanied by narrative reports.

Additional information

Data Sources
Data should be developed specific to the management area.

SE 3 Total employment

Nature of indicator

Definition

The indicator is a description of the total direct employment associated with coastal and ocean-related in the management area. Like total economic value, it can allow comparison to national accounts of the total economy, and for comparison with other national or regional economic areas, and for inter-country comparisons.

Relevance

Total economic value and total employment are "companion indicators" and should be created, compiled and analysed together. Changes in employment within industry classes can be an effective indicator of changes to broader social and cultural dynamics. Changes indicating worker movement out of traditional sectors such as fishing and shipping can signal longer-term changes in cultural dynamics.

Methodological description

Measurement approaches

Total employment should use the same "manner of construction" for the indicator as that used for total economic value (see above). The information developed for the indicator should include both direct employment (numbers of employed) as well as payroll.

The data collection process can also be used to collect other socially-relevant policy information, such as:

- Education levels of persons employed;
- Gender dynamics;
- Training or certification levels required;
- Self-employed versus employee;
- Average size of "establishment";
- Tax (property, income or payroll) contributions.

In all instances this information should be collected for each sector or sub-sector, according to the sectoral/sub-sectoral classification used.

Limitations

"Spin-off" and indirect employment attributions should be avoided in the compilation and analysis.

SE 3 Total employment

Assessment of data

Analysis and interpretation

Time series analysis; assessment of relative changes in economic/industrial structure; seasonal variation; comparisons between and among sectors/uses; comparisons with non-coastal areas; comparisons between the coastal (on-shore; near-shore) and the marine components (Territorial Sea; EEZ; continental shelf) of the management area.

Both total employment and the value of employment (payroll) should be included in the analysis wherever possible.

Reporting scale

National, regional, local.

Output

Tables and maps accompanied by narrative reports.

Additional information

Data sources

Usually, data must be specific to the management area; some general information is available at the following sources:

UN Department of Economic and Social Affairs (UNDESA)
http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=8&Lg=1
European Advisory Committee on Statistical Information in the Economic and Social Spheres (CEIES)
http://epp.eurostat.cec.eu.int/portal/page?_pageid=1193,1440015,1193_1440022&_dad=portal&_schema=PORTAL
North American Industry Classification System (NAICS)
http://www.bls.gov/bls/naics.htm
Global Industry Classification Standard (GICS)
http://www.msci.com/equity/gics.html

SE 4 Sectorial diversification

Nature of indicator

The indicator is a description of the relative importance of one sector of the marine economy relative to another sector (generally in comparison to their relative importance to the total economy of the management area).

Relevance

The degree of diversification in an important component in the consideration of risk – economic risk, ecological risk, and attendant social risk. In general, the greater the dependence on one sector or sub-sector, the higher the risk. Accordingly, economic diversification is often considered to be an important objective in ICOM.

Methodological description

Measurement approaches

A useful generic "manner of construction" of the indicator is described as follows:

1) For the Coastal Zone (land-based activities dependent on the marine environment):
   - Fish and seafood processing
   - Tourism and recreation (local and visitors)
   - Port and shipping (people and goods) activities, including ship-building
   - Other activities that are "water-dependent"

2) For the marine environment (for the extent of the ICOM area out to the boundary of the EEZ or the continental shelf):

a) *Living resource exploitation*
   - Fishing (commercial, recreational, artisanal) activity
   - Aquaculture and mariculture activity
   - Marine plant harvesting
   - Pharmacological or genetic activity

b) *Non-living resource exploitation*
   - Oil and Gas activity
   - Sand, gravel and mineral (e.g., salt) extraction

c) *Non-consumptive use*
   - Electricity generation from wind, tidal or wave energy
   - Eco-tourism

It should be noted that the indicator may be constructed on the basis of economic value, investment, or employment.

Limitations

—

SE 4 Sectorial diversification

Assessment of data

Analysis and interpretation

Time series analysis; assessment of relative changes in economic/industrial structure; seasonal variation; comparisons between and among sector/uses; comparisons with non-coastal areas; comparisons between the coastal (on-shore; near-shore) and the marine components (Territorial Sea; EEZ; continental shelf) of the management area.

Reporting scale

National, regional, local.

Additional information

Data Sources

Data are usually specific to the management area.

SE 5 Human pressures on habitats

Nature of indicator

Definition

The indicator is a measure of the human pressures that contribute to habitat alteration. Habitats should include coastal, riparian and offshore marine habitats.

Relevance

Good habitat quality is essential to maintain ecosystem structure and function – no habitat means no sustainable marine life. An understanding of the extent to which human activities are impacting the habitats is therefore critical to effectively managing those activities.

Methodological description

Measurement approaches

There are several components that should be included in order to provide a comprehensive indication of the extent of impacts on habitats:

- Land use/land cover patterns and composition;
- Population density;
- Extent of hard-surface areas;
- Artificial barriers or constructions;
- Coastal (e.g., beach, mangrove) alteration;
- High-impact fishing gear/practices;
- Dumped and dredged material (e.g., shipping channel maintenance).

Limitations

Not all habitat alterations are harmful or destructive, and human-generated habitat may be beneficial to improved marine environmental quality. Great care, however, should be exercised in making such conclusions – they should only be derived from credible scientific analysis.

Assessment of data

Analysis and interpretation

The amalgamation of the subcategories noted will give an overall indication of the "human footprint" in the marine environment. Interpretive measures (such as the % hard-surfaced rule) are available that can indicate particular problem areas to managers.

Data sources

Environment departments; beach programmes and community monitoring programmes; sectoral management agencies; environmental NGOs; local or regional water and waste-water management agencies; systematic survey of the coastal zone to measure habitat alteration.

Reporting scale

The 1-km Global Land Cover Characteristics Database (GLCCD) has developed a classification listing 15 different kinds of land cover. Each classification has been placed along a dimension from "natural" (least altered) through "semi-altered", to "altered" (most impacted by humans).

Output

Tables and maps accompanied by narrative reports.

Additional information

Global Land Cover Characteristics Database
http://edcaac.usgs.gov/glcc/glcc.html

SE 6 Pollutants and introductions

Nature of indicator

Definition
The indictor is a measure to the total volume and sources of all types of pollutant discharges and introductions in the coastal zone.

Relevance

The degree of complexity of assembly of the indicator will determine its relevance; simple basic measures may provide very useful information to stimulate stronger environmental protection strategies or policies; at its most basic level, the indicator can stimulate public awareness and attention to a problem or a potential problem. With greater degrees of complexity (and associated analysis) the indicator, or its sub-components, may provide sufficient data (such as targets or reference points) to guide management actions.

Methodological description

Measurement approaches
Measurement should include both land- and sea-based sources of pollutants; some of the major categories to be considered include: Population served by wastewater treatment; volume, number, and type of point-source discharges; litter and debris (including lost fishing gear); non-point-source nutrient loading (e.g., fertilizer use); discharged sediments and nutrients; volume of ballast and bilge discharge.

To be effective, all sources within or affecting the management area should be included. While data are often gathered for individual sources, indications of the totality are rarely provided.

Limitations
Data on distant and air-born sources may be not be readily available, making it difficult to develop management measures. Cumulative effects and absorption capacity are useful concepts to enhance the analysis, but can be difficult and costly to determine.

Assessment of data

Analysis and interpretation
The total accumulated assault of pollutants will provide a strong indication of expected overall water quality and of the impact of human activity. The collection of the information may also stimulate attention to the problem in general, as well as to specific problems within each or any of the sub-categories. Further analysis beyond "gross level indicators" may be required to determine which source of pollutants is the most important immediate or long-term threat (in order to set priorities for action).

There are methodologically-sound measures that can be employed for greater analysis (such as maximum absorption capacity of the receiving environment), which can enhance the analysis and allow for more sophisticated regulatory or management actions.

Data sources
Environment departments; beach programmes and community monitoring programmes; sectoral management agencies; environmental NGOs; local or regional water and waste-water management agencies; agencies or companies responsible for or providing electrical generation; government statistical agencies.

Reporting scale
Local, regional, national.

Output
Narrative reports accompanied by tables and maps.

Additional information

—

SE 7 Disease and illness

Nature of indicator

Definition

The indicator is a measure of the extent to which human health has been negatively affected by the water and species quality in the marine environment.

Relevance

The indicator is relevant to understand both the short-term and the long-term consequences of marine environmental quality. While the most immediate relevance is to human health, there are also important economic consequences (e.g., the economic value of days lost due to illness, the short and long-term economic cost of areas closed to fishing, the short and long-term impact on tourism). The information is also relevant for cost/benefit analysis (e.g., of enhanced wastewater treatment.) The introduction of under- or un-treated human waste is the primary cause of lost fishing value, lost coastal recreational value and increased source of public health risk

Methodological description

Measurement approaches

Measurement should consider a mixture of "source" and "consequence" information: Fecal coliform counts; days of beach closure; extent of contaminated species; extent of contaminated water; seafood-vectored illnesses (including chronic long-term accumulation).

Limitations

Measurement of terms such as "improved" sanitation may differ from region to region even when reported by a single international organization. In some instances, it may mean no access to any sanitation while in other others it may mean that the existing facilities fall short of regional norms.

SE 7 Disease and illness

Assessment of data

Analysis and interpretation

International standard for bathing water quality have been developed through a group of experts headed by the World Health Organization (WHO). The so-called "Annapolis Protocol" is being used by an increasingly large number of countries to establish both standards and measurement protocols.

Measurement of contaminants may be particularly important for indigenous populations, who have a high reliance on marine-sourced food sources.

More sophisticated economic modeling is available to determine the economic consequences of disease and illness (e.g., see GESAMP: A Sea of Troubles)

Data sources

Public health authorities, government environment departments (national, sub-national); hospitals; WHO; FAO.

Reporting scale

Local, regional, national, international.

Output

Narrative reports accompanied by tables and maps.

Additional information

Guidelines for analysis and interpretation are available through the WHO.
http://www.who.int/entity/ water_sanitation_health/bathing/Annapolis.pdf

World Bank Group. Water Supply and Sanitation Programme.
http://www.wsp.org

World Health Organization: Water, Sanitation and Health
http://www.who.int/docstore/water_sanitation_health/

U.S. Environmental Protection Agency, BEACON, Beach Advisory and Closing On-line Notification
http://oaspub.epa.gov/beacon/beacon_data.about_beacon

European Blue Flag System
http://www.blueflag.org/BlueFlagMap.asp

SE 8 Weather and disaster

Nature of indicator

Definition
The indicator provides information on the extent to which human lives and property are affected by weather and marine disaster events.

Relevance

Understanding the economic and social consequences of living in a coastal environment is important. Such an understanding usually predates management actions to control or mitigate the consequences of these events. It is also often required to stimulate necessary investment in oceanographic prediction and control devices and associated modeling and analysis. It is also relevant for an assessment of the consequences of human-induced coastal habitat alteration that may exacerbate the impact of weather events.

Methodological description

Measurement approaches
Economic value of loss from marine weather-related events; lives lost from weather and marine disasters.

Limitations
Causal relationships between human coastal habitat alteration and weather-related impacts (or the exacerbation on weather-related impact) may be difficult to prove definitively.

Assessment of data

Analysis and interpretation
Evaluating direct loss (economic or human lives) from weather-related events is generally straight-forward; long-term and indirect consequences can be more difficult to determine.

Data sources
Government emergency preparedness and planning agencies; insurance companies; hospital and public health authorities; NGOs.

Reporting scale
Local, regional, national.

Output
Narrative reports accompanied by tables and maps.

Additional information

—

SE 9 Population dynamics

Nature of indicator

Definition

The indicator of the linkages between humans and the coastal and marine area (over and above the linkages that are implicit in an economic sense as provided in "total economic value, SE 1)

Relevance

Understanding the importance of the human linkage to the coastal and marine environment is important for management purposes, and for creating within the population (and governments) an empirical sense of the importance of the area. The distribution and changes in population density and in the composition of the population can be as, or more important than total population. The spread of population into previously uninhabited areas can increase the destruction and fragmentation of coastal habitat, contaminate coastal waters with a variety of pollutants and expose new resources to exploitation. The dynamics of "sprawl" is different than increased population within the existing footprint of human habitation.

Methodological description

Measurement approaches

Resident and total (seasonal) population; degree of public access.

The unit of measurement of population is number of persons – population estimates are usually based on national population censuses and revised (in-between) censuses, which collect data on births, deaths and migration. Resident population alone is a core variable; however, trend analysis, spatial distribution dynamics, population class analysis, and non-resident and seasonal population data provide substantial insight for managers.

The term "marine attachment" or "water dependent use" means a use, activity, or project that requires direct physical location on, proximity or access to a body of water. While water dependency is met solely because of a requirement for water, marine attachment is determined by economic advantages that may be gained from a coastal waterfront location. Social dynamics (intrinsic "value") may need to be determined from social surveys of the population, but is still an important consideration for managers and governments.

Another measure of attachment is given by the degree of public access to the coastal area. In many jurisdictions, land ownership rules and deed restrictions preclude full and open access to coastal areas and resources.

Limitations

The quality of census data varies broadly among countries and among regions.

Assessment of data

Analysis and interpretation

Understanding the importance of the linkage to the coastal and marine environment is important for oceans and coastal management purposes, and for creating within the population (and governments) an empirical sense of the importance of the area.

Data sources

Population census data; local governments; surveys.

Reporting scale

Local and regional.

Output

Narrative reports accompanied by tables and maps.

Additional information

—

SE 10 Marine Attachment

Nature of indicator

Definition
The indicator is a measure of the social and economic "relevance" of the marine environment to the population of the ICOM management area.

Relevance

Understanding the importance of social and economic linkage between the population and the coastal and marine environment is important for ICOM purposes. It is also vital for creating within the population (and governments) an empirical sense of the importance of the area.

Methodological description

Measurement Approaches
There are two different types of "attachment": an economic attachment and a social attachment to the marine environment.

The economic attachment may be referred to as "water- dependent use"; this means a use, activity, or project that requires direct physical location on, or proximity or access to a body of coastal water.

While water-dependency is met solely because of a requirement for water, the economic definition of marine attachment may also be broadened to include consideration of the economic advantages that may be gained from a coastal waterfront location.

Social attachment refers to the intrinsic "value" that the population derives from the marine environment. This needs to be determined from social surveys of the population, and is an important consideration for managers and governments. The historical connection to the marine environment (e.g., the number of generations families have lived in proximity or connected to the marine environment) is an important component of social dynamics that managers should consider when designing population surveys.

Limitations
—

Assessment of data

Analysis and Interpretation
Qualitative data on social attachment and intrinsic value may be very subjective.

Economic data on "attachment" and water-dependent use are easier to collect, but provide an incomplete picture of the importance of the area to those living in the area.

Data Sources
Surveys; local governments; business associations; local societies (e.g., historical societies).

Reporting Scale
Local and regional.

Output
Narrative reports accompanied by tables and maps.

Additional information

—

SE 11 Public access

Nature of indicator

Definition
The indicator is a measure of the degree to which the public have access to the coast itself, and to the resources of the coastal and marine environment.

Relevance

There is both a social and economic component to public access.

The social component deals with the extent to which the population - the local resident population or the non-resident population (e.g., tourists) have physical access to the coast. In many jurisdictions, land-ownership rules and deed restrictions preclude full and open access to coastal areas.

The economic component deals with the extent to which the local population has access to the resources of the marine environment (either the living resources or the non-living resources). Note: "local population" may also mean the national population in areas where access to offshore resources has been given to non-nationals. This may also include consideration of the "economic rents", if any, charged by governments for access to those resources (e.g., license or permit fees; taxes; royalty fees).

Methodological description

Measurement Approaches
Physical access: area (km) of public access; number of access points/km of coastline; public versus private ownership of the coastline.
Economic access: percentage of resource rights given to the local/national population; economic value of local/national resource rights in relation to total economic value of the area.

Limitations
—

Assessment of data

Analysis and Interpretation
—

Data Sources
—

Reporting Scale
Local and regional.

Output
Narrative reports accompanied by tables and maps.

Additional information

—

SE 12 Traditional knowledge, innovations and practices / Cultural integrity

Nature of indicator

Definition

The degree to which traditional knowledge, innovations and practices are recognized and utilized in the management of coastal and marine areas and resources.

Units of measurement

The indicator can be based on multiple measures, considering the issues that are most relevant:

- Status and trends in linguistic diversity and speakers of indigenous languages (language);
- Recognition/existence/continuation of traditional land and water tenure of indigenous and local communities (land; see also land-use/land-cover patterns and composition);
- Lands and waters managed or co-managed by indigenous and local communities (land; see also land-use/land-cover patterns and composition);
- Movement of indigenous and local communities away from traditional territories and inflow of new communities (people; see also population density);
- Trends in the establishment and effective implementation of favourable government policies and programmes to preserve traditional knowledge, innovation and practice (programmes and policies);
- Access to traditional coastal and marine resource rights (culture; see also land-use/land-cover patterns and composition);
- Trends in the manifestations of traditional knowledge (culture).

Relevance

Purpose

The use of indicators and measures related to traditional knowledge, innovation and practices can provide an evaluation of cultural integrity.

International conventions, agreements, targets

- The CBD recently developed indicators to track the implementation of the respect, preservation and maintenance of knowledge, innovation and practices of indigenous and local communities, in particular for assessing progress towards the 2010 biodiversity target.
- UN Declaration on the Rights of Indigenous Peoples: The UN Commission on Human Rights has established an open-ended, inter-sessional working group to elaborate a draft UN Declaration on the Rights of Indigenous Peoples. Work is in progress.

SE 12 Traditional knowledge, innovations and practices / Cultural integrity

Methodological description

Underlying definitions and concepts

Traditional knowledge and traditional resources have been managed by indigenous and local communities since time immemorial, using customary law embedded in spiritual cosmology. Persistence of customary law, and/or the existence of knowledge holders, spiritual leaders or Elders and the persistence of cultural practices may all be regarded as manifestations of traditional knowledge. These can be useful indicators that traditional knowledge continues to be used and passed on to younger generations (UNEP/CBD/WG8J/4/10).

Measurement approaches

As no one single indicator can capture the status and trends of traditional knowledge, innovation and practices in relation to coastal and marine resource management, a series of measures are proposed and can be selected, depending on the issues at stake. As much as possible, the measures proposed should be determined in both a qualitative and quantitative way, focusing on the aspects most relevant to the ICOM initiative under evaluation (e.g., availability of documents in traditional languages). The indicator may require significant customization on the part of the users to be relevant to the ICOM initiative.

Limitations

Limitations of the indicator and its measures are related to both its conceptual and operational definition and the availability of data at the required scale.

Status of the methodology

The methodology is under development in other forums (in particular, CBD Ad hoc Open-ended Inter-sessional Working Group and Related Provisions of the CBD and UNESCO).

Alternative definitions

—

SE 12 Traditional knowledge, innovations and practices / Cultural integrity

Assessment of data

Data needed to compile the indicator

Quantitative and qualitative data on the selected trends in traditional knowledge, innovation and practices.

Data sources and collection methods

Data may be available from national statistics and censuses as well as public programmes and policies relevant to status and trends in traditional knowledge and local community self-assessments. The collection of new data may require the conduct of surveys or local community self-assessments exercises.

Analysis and interpretation of data

The description and analysis of data should be performed with reference to the goals and objectives of the ICOM initiatives, highlighting the aspects of and trends in traditional knowledge that are most relevant to the sustainable use, conservation and management of coastal and marine resources and wellbeing of coastal communities. Gender implications will have to be taken into account in the measurement of the indicator.

Reporting scale and output

The indicator is best monitored at the level of coastal territories in which traditional communities live. The output may include graphic representations (e.g., maps).

Additional information

Organizations and programmes involved in the development of the indicator

- Secretariat of CBD; UNESCO; CBD, Ad Hoc Open-ended Intersessional Working Group on Article 8(j) and related provisions of the Convention on Biological Diversity, Final Report, UNEP/CBD/COP/8/7.
- UNESCO (2000). Cultural Diversity, Conflict and Pluralism. UNESCO, Paris.

Internet links

CBD: http://www.biodiv.org/programmes/socio-eco/traditional/default.asp
UNESCO: http://portal.unesco.org/culture/en/ev.php-URL_ID=2450&URL_DO=DO_TOPIC&URL_SECTION=201.html

SE 13 Protection of coastal heritage resources

Nature of indicator

Definition
The degree to which coastal heritage resources are known, effectively protected, and enjoyed.

Units of measurement
- The number and type of coastal heritage resources identified and assessed;
- The percentage of coastal heritage resources, including cultural routes, that are protected, both formally and informally;
- The percentage of coastal heritage resources that are vulnerable or being damaged because of natural (e.g., coastal erosion) and human (e.g., reclamation, inappropriate use, etc.) factors;
- Use of cultural heritage resources and most visited sites.

Relevance

Purpose
The knowledge, protection, and enjoyment of the heritage resources of the coastal area contribute to environmental protection in the broader sense. These resources represent evidence of the cultural environment and its historic and cultural life evolution.

International conventions, agreements, targets
Several global and regional instruments protect material cultural heritage of different types. Among the most important instruments are: World Heritage Convention 1972; European Convention on the Protection of the Archaeological Heritage (revised) 1992; European Landscape Convention 2000; Recommendation 1486 (2000) of the Parliamentary Assembly of the Council of Europe on Maritime and fluvial cultural heritage; Convention on the Protection of the Underwater Cultural Heritage 2001.

Methodological description

Underlying definitions and concepts
Coastal cultural heritage includes historical, archaeological and/core cultural, including sacred, resources, including objects, sites and landscapes located in the coastal area, both on land and underwater.

Measurement approaches
The indicator may be measured on different levels, including the degree to which such resources have been assessed, formally and informally protected—including through traditional/religious rules/customs—and safeguarded (including conservation, preservation, restoration, and reconstruction).

Limitations of the indicator
Limitation of the indicator can be found in the definition of the specific features that account for coastal cultural heritage, their values and significance, contribution to coastal economy, and vulnerability.

Status of the methodology
The methodologies for the measurement of this indicator rely on general methodologies for monitoring cultural heritage.

Alternative definitions
—

SE 13 Protection of coastal heritage resources

Assessment of data

Data needed to compile the indicator

Quantitative and qualitative data on the location and typology of cultural heritage resources, their state, level and effectiveness of protection, and enjoyment.

Data sources and collection methods

Agencies in charge of safeguarding material heritage and relevant registers. Data can come from reviews of registers, aerial surveys and fieldwork.

Analysis and interpretation of data

The description and analysis of the data should aim to identify specific issues with cultural heritage located in the coastal zone, including their exposure to natural factors and their contribution to the coastal economy.

Reporting scale and output

The indicator is best monitored at the level of coastal administrative units (e.g., coastal provinces). The output may include sorted lists of coastal cultural heritage resources and graphic representations (e.g., maps).

Additional information

Organizations and programs involved in the development of the indicator

UNESCO World Heritage Centre (WHC); Council of Europe (CoE); Regional Activity Centre for the Priority Actions Programme (PAP/RAC); World Bank.

References

Pearson, M., Johnston, D., Lennon, J., McBryde, I., Marshall, D., Nash, D. and Wellington, B. (1998). Environmental Indicators for National State of the Environment Reporting – Natural and Cultural Heritage. Australia: State of the Environment. Environmental Indicator Reports. Department of the Environment, Canberra.

World Bank (1994). Environmental Assessment Sourcebook Update no. 8, Cultural Heritage in Environmental Assessment. World Bank, Washington, DC.

Internet links

UNESCO WHC: http://whc.unesco.org

CoE, Cultural and Natural Heritage: http://www.coe.int/T/E/Cultural_Co-operation/Heritage/

PAP/RAC: www.pap-thecoastcentre.org/

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)
	Vol. IV: An Update to 2006. 2006. 78 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)

No.	Title
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) [superseded by a sale publication in 2003, 92-3-103871-0. UNESCO Publishing]
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. 2004. 35 pp. (English)
45	A Reference Guide on the Use of Indicators for Integrated Coastal Management. 2003. 127 pp. (English). ICAM Dossier No. 1
46	A Handbook for Measuring the Progress and Outcomes of Integrated Coastal and Ocean Management. 2006. iv + 217 pp. (English). ICAM Dossier No. 2

United Nations
Educational, Scientific and
Cultural Organization

Intergovernmental
Oceanographic
Commission

Intergovernmental Oceanographic Commission (IOC)
United Nations Educational, Scientific and Cultural Organization
1, rue Miollis
75732 Paris Cedex 15, France
Tel: +33 1 45 68 10 10
Fax: +33 1 45 68 58 12
Website: http://ioc.unesco.org