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Review of Ecosystem-Based Indicators and Indices on the State of the Regional Seas

Review of ecosystem-based indicators and indices on the state of the Regional Seas

FINAL REPORT

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Executive Summary

Indicators can provide information to guide sustainable management. Ecosystem-based indicators can apply both to the state of the marine environment and to considerations of performance against environmental targets and/or limits in a defined geographical area. In order to guide management, indicators should be set within a reference framework and hierarchies of indicators can provide coordinated support. In time current ecosystem-based indicators are likely to embrace ecosystem service indicators and synergies should be considered when considering any relevant strategic development.

The Ecosystem Approach is widely accepted in international and national policy as a valuable framework to guide the sustainable development of marine and coastal ecosystems. In addition to factoring in human activities and social choices more emphasis is placed on integrity of the ecosystem than previous site-based and/or target species approaches to conservation. Application of the Ecosystem Approach to marine regions relies on establishing a coordinated system of ecological and operational objectives, informed by indicators, limits and targets. Such applications have been implemented in the marine context with varying success by the United Nations Environment Programme (UNEP) Regional Seas Programme (RSP), Global Environment Facility-Large Marine Ecosystem Projects (GEF-LMEs) and a number of global initiatives with regional dimensions. A better understanding of which indicators are being used, and their utility in demonstrating application of the Ecosystem Approach at the regional scale, would help make more explicit the value of regional entities and strengthen arguments to support their work. Furthermore it makes sense to avoid duplication. Regional indices should ideally nest within and feed global initiatives established to measure environmental condition or change (these range between using 4 - 260 indicators) with the intention of reporting on sustainable development progress and/or state of the environment. Lessons can be learned from the on-going development of indicators and a reporting mechanism for monitoring and evaluation of implementation of the United Nations Forest Instrument (UNFI).

This study considers the relevance of a 'coordinated set' of indicators capable of comparing common regional marine ecosystem issues. The report collates information on ecosystem-based indicators and indices currently being measure by regional entities and seeks to identify common elements. From this analysis the report postulates whether a limited generic set of indicators can be derived. A series of case studies are used to exemplify the diversity of ways indicators have been applied. For State of the Environment reporting, ecosystem-based indicator systems have developed in an *ad hoc* way, influenced by regional pressures and priorities. Indicator systems linked to targets and objectives have been more coordinated (e.g. Transboundary Waters Assessment Programme) and the European Environment Agency (EEA) approach to indicators is an example of pan-regional coordination associated with regulatory requirements. Indicator information is most usually collected on an annual basis but this is not always the case with the possibility of some near real time data collection. Most indicator systems in place are being adapted and refined based upon evaluations of their usefulness and practicality. However, all regional entities regard them as costly and technically challenging. There is something of a mismatch between expectations of policy and ability to achieve reporting needs and an opportunity to consider which global data and information streams can best serve to support the needs of the RSP.

The current use of marine ecosystem-based indicators and indices by regional entities is both overwhelming in terms of numbers being used and disparate in terms of the different indicators, systems and terminology employed. The analysis of indicators currently being used highlights different levels of specificity, wide variation in terms of the numbers of indicators, different rationales for indicator selection, different levels of sophistication and, for some parameters, the use of qualitative indicator statements. When trying to compare regions, rather than clarifying, this complexity clouds and confuses any underlying messages that may emerge. Indicators in themselves are not

sufficient to describe or understand progress against a baseline. To contribute to governance efforts indicators should inform ecological and operational objectives. The RSP should and can input to regular global quality status and any such reports could interface and complement the World Ocean Assessment as well as contributing (and if appropriate adapting to) an ocean-related Sustainable Development Goal.

This report puts forward a draft set of coordinated indicators reflecting approaches already underway within the RSP. In doing so it provides a draft framework that does not impose extra work for Regional Seas Conventions and Action Plans but rather proposes the use of existing indicators that fulfill multiple reporting requirements and combines with existing RSP obligations using the Regional Seas Marine Biodiversity and Outlook Series as a point of departure. At the same time it is acknowledged that too many indicators blur any policy message. What is wanted is a process to underpin a communication tool. In other words an achievable limited set of ecosystem-based indicators agreed by the RSP and endorsed by UNEP. Choosing appropriate metrics that can be agreed collectively requires further work and the opportunity for a more substantive collective technical discussion. Such a discussion should feed into agreed global assessment processes (such as Aichi Targets) and should anticipate an interface with Sustainable Development Goals. An illustrative approach towards defining a collective 'coordinated set' is proposed.

We conclude that a 'coordinated set' of indicators should be purpose dependent relating explicitly to 'healthy oceans'. It should harmonize effort rather than adding to reporting burdens and provide an opportunity to bring together the work of the RSP and GEF-LMEs. To achieve this we recommend further consideration of work underway by UNFF and EEA, together with the application of lessons learned from the Biodiversity Indicators Partnership, and the need for a technical workshop to consolidate indicator selection and agree common data / information sources.

Glossary of terms

ASC	Agulhas and Somali Current
ASCLME	Agulhas and Somali Current Large Marine Ecosystems Project
ATS	Arafura and Timor Seas
ATSEA	Arafura and Timor Seas Action Plan
BCLME	Benguela Current Large Marine Ecosystem
BD	Biodiversity
BOBLME	Bay of Bengal Large Marine Ecosystem Project
BOD	Biological/Biochemical Oxygen Demand
BSAP	Baltic Sea Action Plan
BSC	Black Sea Commission
BSIMAP	Black Sea Integrated Monitoring and Assessment Program
BSIS	Black Sea Information System
BSSAP	Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea
CAFF	Conservation of Arctic Fauna and Flora
CBD	Convention on Biological Diversity
CCA	Causal Chain Analysis
CCAMLR	Commission for the Conservation of Antarctic Living Resources
CEMP	CCAMLR Ecosystem Monitoring Program
CEP	Caribbean Environment Programme
CFC	Chlorofluorocarbon
Chl/ Chl a	Chlorophyll/ Chlorophyll a
CI	Conservation International
CIMAB	Center of Engineering and Environmental Management of Coasts and Bays
CLME	Caribbean Large Marine Ecosystem Project
CO2	Carbon Dioxide
COD	Chemical Oxygen Demand
COP	Conference of the Parties
CPPS	Comisión Permanente del Pacifico Sur
CPUE	Catch Per Unit Effort
CSD	(UN) Commission on Sustainable Development
CSI	Core Set Indicator
CSIRO	Commonwealth Scientific and Industrial Research Organisation
DPSIR	Drivers-Pressures-State-Impacts-Response
EAS	East Asia Seas
EC-DG	European Commission / Directorate-General
EcoQO	Ecosystem Quality Objective
EEA	European Environment Agency
EEZ	Exclusive Economic Zone
EO	UNEP/MAP Ecological Objective
EQO	Ecological Quality Objective
EU	European Union
EVI	Environmental Vulnerability Index
FAO	Food and Agriculture Organization
FiB	Fishing in Balance Index
FRA	Forest Resources Assessment
GCLME	Guinea Current Marge Marine Ecosystem Project
GCRMN	Global Coral Reef Monitoring Network
GDP	Gross Domestic Product
GEF	Global Environment Facility
GEF-LME	Global Environment Facility-Large Marine Ecosystem Projects
GEO	(UNEP) Global Environment Outlook
GES	Good Environmental Status
GHG	Green House Gas
GIWA	Global International Waters Assessment
GLOC	Global Conference on Land-Oceans Connection
GLOSS	Global Sea Level Observing System

GOBI	Global Ocean Biodiversity Initiative
GOMLME	Gulf of Mexico Large Marine Ecosystem
GOOS	Global Ocean Observing System
GPA	Global Programme of Action for the Protection of the Marine Environment from Land-based sources
GRID	(UNEP) Global Resource and Information Database
HAB	Harmful Algal Blooms
HCLME	Humboldt Current Large Marine Ecosystem
HDI	Human Development Index
HELCOM	Helsinki Commission
HOD	Heads of Delegation
IAS	Invasive Alien Species
ICES	International Council for the Exploration of the Sea
ICM	Integrated Coastal Management
ICZM	Integrated Coastal Zone Management
IOC	Intergovernmental Oceanographic Commission
IOGOOS	Indian Ocean Global Ocean Observing System
IPBES	Intergovernmental Platform on Biodiversity and Ecosystem Services
ISR	Integrated Study Regions
ITTO	International Tropical Timber Organization
IUCN	International Union for Conservation of Nature
IUU	Illegal, unreported and unregulated
IW	International Waters
JAMP	Joint Assessment and Monitoring Programme
LBS	Land-based sources
LME	Large Marine Ecosystems
MAP	Mediterranean Action Plan
MDG	Millennium Development Goals
MEA	Millennium Ecosystem Assessment
MEOW	Marine Ecoregions of the World
MONAS	HELCOM Monitoring and Assessment Strategy
MPA	Marine Protected Area
MSFD	Marine Strategy Framework Directive
MSSD	Mediterranean Strategy for Sustainable Development
MSY	Maximum Sustainable Yield
MTI	Marine Trophic Index
MYPOW	Multi-Year Programme of Work
N	Nitrogen
NAP	National Action Plan
NGO	Non-Governmental Organization
NH3	Ammonia
NIP	National Implementation Plan
NIS	Non-Indigenous Species
NOAA	National Oceanic and Atmospheric Administration
NOWPAP	Northwest Pacific Action Plan
NOx	Nitrogen oxides
OBIS	Ocean Biogeographic Information System
ODS	Ocean Data Standards Pilot Project
OECD	Organisation for Economic Co-operation and Development
OHI	Ocean Health Index
ORP	Oxidation-Reduction Potential
OSPAR	OSPAR Commission: Convention for the Protection of the Environment of the North-East Atlantic
OSY	Optimum Sustainable Yield
PAH	Polyaromatic hydrocarbon
PAME	Protection of the Arctic Marine Environment
PCB	Polychlorinated biphenyl
PEMSEA	Partnerships in Environmental Management for the Seas of East Asia
PERSGA	The Regional Organization for the Conservation of the Environment of the Red Sea & Gulf of Aden

PICES	North Pacific Marine Science Organization
PMA	Pollution Monitoring and Assessment
POC	Particulate Organic Carbon
POP	Persistent Organic Pollutant
PSR	Pressure-State-Response
PTB	Persistence, Bioaccumulation, Toxicity
PTS	Persistent Toxic Substance
QSR	Quality Status Report
RAC	Regional Activity Center
RAM	Rapid Assessment Method
REMPEITC	Regional Marine Pollution Emergency Information and Training Centre
RFB	Regional Fishing Body
RIIS	ROPME Integrated Information System
ROPME	Regional Organization for the Protection of the Marine Environment
RSCAP	Regional Seas Convention and Action Plan
RSP	Regional Seas Programme
S/W	Specific surface of macrophyte species
SACEP	South Asian Co-operative Environment Programme
SAP	Strategic Action Programme; Strategic Action Plan
SAS	South Asian Seas
SASP	South Asian Seas Programme
SAUP	Sea Around Us Project
SCS	South China Sea Project
SDG	Sustainable Development Goals
SDS-SEA	Sustainable Development Strategy for the Seas of East Asia
SEEA	(UN) System of Environmental-Economic Accounting
SIDS	Small Island Developing States
SOC	State of the Coasts
SOCR	State of Convention Area Report
SOx	Sulphur oxides
SPAW	Specially Protected Areas and Wildlife
SPREP	Secretariat of the Pacific Regional Environment Programme
SSM	Standard Survey Method
SST	Sea Surface Temperature
TBT	Tributyltin
TDA	Transboundary Diagnostic Analyses
TEEB	The Economics of Ecosystems and Biodiversity initiative
TWAP	Transboundary Waters Assessment Programme
UBC-SAUP	University of British Columbia - Sea Around Us Project
UkrSCES	Ukrainian Scientific Centre for Ecology of the Sea
UN	United Nations
UNCSD	United Nations Conference on Sustainable Development
UNEP	United Nations Environment Programme
UNFF	United Nations Forum on Forests
UNFI	United Nations Forest Instrument
UNGA	United Nations General Assembly
USD	United States Dollar
USEPA	United States Environmental Protection Agency
VME	Vulnerable Marine Ecosystem
WACAF	Abidjan Convention
WCMC	(UNEP) World Conservation Monitoring Centre
WDPA	World Database on Protected Areas
WFD	Water Framework Directive
WG-EMM	CCAMLR Working Group on Ecosystem Monitoring and Management
WHO	World Health Organization
WIO	Western Indian Ocean
WOA	World Ocean Assessment
WOD	World Ocean Database
WRI	World Resources Institute
YSLME	Yellow Sea Large Marine Ecosystem

Contents

1. Introduction

1.1 This chapter sets out some fundamental definitions and an interpretation of concepts that underpin this report. Basic information is drawn from secondary sources in a body of literature reflecting ideas debated over the past decades. Although some aspects are the subject of on-going research, and different terms are used by different organisations and regions, it is generally accepted that these terms are in common use as defined in various inter-governmental forums.

What is an indicator?

1.2 Definitions of the term 'indicator' are drawn from the Latin verb '*indicare*', meaning to disclose or point out, to announce or make publically known, or to estimate or put a price on (Hammond *et al.*, 1995, p1). The intention is to simplify, quantify, standardize, and communicate. In other words, to rationally explain complex information as a contribution to assessing conditions (Figure 1.1). For a given issue information can be measured, weighted, aggregated and may be presented within a composite index over time. The result of such an exercise is generally a set of compressed data demonstrating any trend, with the objective/purpose of being understandable to and raising awareness among policy-makers and civil society (UN, 2007).

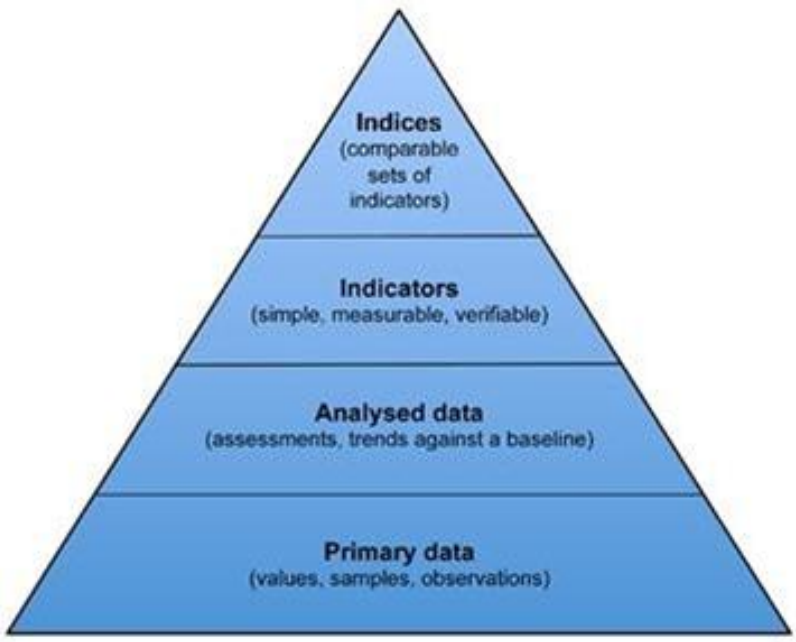

Figure 1.1: The information pyramid of environmental indicators

1.3 In 2010 the Biodiversity Indicators Partnership (UNEP-WCMC, 2010) set out the following definitions, amplified here from UNEP(2011a):

- **Measure**: a value that is quantified against a standard at a point in time;
- **Metric**: a set of measurements or data collected and used to underpin each indicator e.g. GDP per capita. Metrics usually have units;
- **Indicator**: a measure or metric based on verifiable data that conveys information about more than itself. It is information packaged to communicate something important to decision-makers. Generally a combination of two or more metrics (e.g. economic dependency on water resources). Indicators may or may not have units, depending on how they are formed;
- **Index**: a numerical scale used to compare variables with one another or with some reference number. A combination of two or more indicators (e.g. socioeconomic index). Indices are generally dimensionless and usually have normalized scores.

1.4 From a range of possible indicators, it is important to select the most relevant for each situation. Desirable characteristics are (Hammond *et al*., 1995; IOC, 2006; Johnson, 2008; Vilares, 2010; Douvere and Ehler, 2011):

--- political relevance (governance performance);
--- data and information are readily available (i.e. cost-effectiveness;
--- context sensitivity: sensitive to changes in aspects being monitored and allowing the detection of trends or impacts resulting from plan implementation (i.e. specific and responsive);
--- comparability (in time and space allowing for interregional or international comparisons);
--- robustness and scientific credibility;
--- show trends over time (i.e. interpretable);
--- scientifically sound (i.e. grounded in theory);
--- concrete, and easily understood;
--- measurable, specific, and capable of being updated regularly; and
--- adapted to intended users, so that they answer the needs of their different target-groups.

1.5 Selected indicators should satisfy the greatest possible number of criteria, so as to contain costs and maximize resources and promote greater efficacy of the monitoring/evaluation system to be implemented (Diedrich *et al*., 2010; Vilares, 2010). They should also contain consistent information to allow reporting at different scales (national, regional and international) and across different jurisdictions (Diedrich *et al*., 2010). “While not all criteria are likely to be met on every occasion, the main themes or messages that emerge are that indicators have to be simple, measurable and responsive.” (Gubbay, 2004, p.16).

1.6 In turn, these can be grouped in two main categories (MAOT, 2010b; Vilares, 2010):

--- **Efficiency indicators**, measuring the performance of different programme components and the progress and quality of interventions and of the governance process itself; and,
- **Efficacy indicators** (ecological and socio-economic), reflecting tendencies in the state of the environment and in the state of the human component of coastal and marine ecosystems (economic activity). They help measure to what extent an instrument is contributing to manage human pressures in a way that results in an improved natural environment as well as in sustainable socio-economic benefits.

Where do indicators stand in the planning/management cycle? A coordinated system of objectives, indicators, limits and targets

1.7 Indicators constitute the link between policy and operational objectives and action in management (FAO, 1999; Day, 2008; Ehler and Douvere, 2009; Government of Canada, 2007; IOC, 2006; Douvere and Ehler, 2011). As such, they are fundamental tools to monitor and evaluate plans, programmes and policies and to inform their adaptations and revisions (Degnbol, 2005), and, thus, should be clearly related with the specific issues that triggered each particular planning/management process (IOC, 2006). This link as part of a management strategy is illustrated below in Table 1.1.

Strategic goals	To phase out pollution in the marine environment
Ecological objectives	Reduce impact of contaminants
Operational objectives	Reduce contaminant levels in shellfish species x
Indicators	Concentration of contaminant in shellfish species x
Targets and limits	Concentration of contaminant = a (target) or < b (limit)

Table 1.1: Role of indicators in a management system (ICES, 2005)

1.8 So that changes in the "behaviour" of any given indicator are meaningful and interpretable for managers and decision-makers, **indicator specific reference points** need to be developed (Blanchard et al 2010; ICES, 2012; IOC 2006, Vilares, 2010). The definition of references "against which to measure the success or failure of management actions" is paramount to assist decisionmakers in designing better policies and instruments (Ecologic Institute and SERI, 2010).

1.9 Although there is some terminological confusion in the literature (with the same terms being used with different meanings), there are three main types of reference points/values:

- baseline value: the indicator's value at time zero (keeping in mind that such values may be well below historic values) (Pauly, 1995; Roberts, 2007);
- target or optimum value: the desired value for the indicator over a given period of time; and
- limit or threshold value (to control negative tendencies). Threshold values correspond to tipping points "beyond which serious and/or irreversible - and usually negative or undesired - changes in environmental systems occur" (Ecologic Institute and SERI, 2010, p.13).

1.10 A further refinement on the definition of threshold levels might be the determination of an alert level or value, being "the critical value beyond which there is no safe distance from dangerous thresholds" and of danger zones as "the range of values outside the safe operating zone, which indicate a high probability and subsequently a high risk to reach the threshold levels (Ecologic Institute and SERI, 2010, p.7).

Transboundary indicators/indicators of transboundary effects

1.11 The establishment of transboundary or cross-border indicators is particularly challenging but their definition is extremely important as it promotes the establishment of a common understanding of transboundary ecosystem priorities for action (Wong et al., 2011, p.1) and monitoring. Such a common understanding is particularly pressing in times of scarcity of resources (including funding sources),

when it is especially important to establish and maintain sustained monitoring efforts of key management aspects that may have cross-border implications.

1.12 Across political borders and physical interfaces there will be different plans/policies relevant for marine governance, each with different goals and sets of objectives, and concurrently, proposing different sets of actions (management measures). “For an assessment to have impact, it needs to carry clear, high-level messages about the issues raised, and point towards interventions in governance that can help mediate the relationship between humans and the oceans, improving human well-being”(IOC-UNESCO, 2011b, p.2).

Linking effects with causes

1.13 The selection of relevant indicators should be able to link measured metrics with specific activities (taking place in specific areas of the maritime space) or causes. Of course, the relation of top holistic indicators with causes of pressure or impact on marine ecosystems or their components may be blurred or difficult to pinpoint due to the fluid/dynamic nature of the marine environment and as a result of the interconnectedness of ecosystem components. This means that such top indicators must be based or be coupled to more detailed or underlying traceable indicators/data that may provide a more explicit link to causality.

1.14 It should be possible to establish common broad indicators that may be identically measured/monitored (comparable methodologies) within a given region and between regions. These broad indicators will hopefully allow for the detection of changes in the measured parameters, which, in turn, should elicit adapted management actions to correct the changes detected. Conversely, these management actions need not be identical since they will have to be adapted to the existing governance scheme on either side of the border.

1.15 Highlighting vital common management issues will help to assist in the selection of a reduced set of indicators. In turn, a reduced set of indicators is a key condition for the actual implementation of the monitoring efforts and it is a better way to draw attention to key issues, as, in order for an assessment to have impact “the number of key indicators and key messages has to be limited” (IOCUNESCO, 2011b, p.2).

1.16 To support management at the regional level and between regions hierarchies of indicators are desirable feeding into larger scale (pan-regional) reporting. For example this might consider the proportion of a region with 100% of habitat impacted < target %, as compared to the proportion of all habitat types impact < target % within an individual region.

Sustainable development indicators

1.17 In a context of planning and management based on a paradigm of sustainable development three main types of indicators have to be considered - governance, socio-economic and ecological - as well as the linkages or interactions between them (IOC, 2006; Pintér et al., 2012).

1.18 Recognizing that these three pillars are irrevocably linked, the Organization for Economic Co-operation and Development (OECD) proposed, in 1993, a framework for their integrated consideration known as Pressure-State-Response (PSR). It is “based on a concept of causality”, where **pressures** exerted by human activities on the environment (ecological, chemical or physical indicators), lead to changes in its **state** (quality and quantity of natural resources described by ecological indicators), triggering societal/management **responses** through environmental, economic and sectoral policies

(technical and institutional indicators) (OECD, 1993). These should, in turn, influence initial pressures. An illustrative matrix of such indicators is shown below in Table 1.2.

Issues	Pressure	State	Response
Climate change	GHG emissions	Concentrations	Energy intensity; environmental measures
Ozone depletion	(Halocarbon) emissions; production	(Chlorine) concentrations; O_3 column	Protocol sign.; CFC recovery; Fund contribution
Eutrophication	(N, P, water, soil) emissions	(N, P, BOD) concentrations	Treatment connections; investments/costs
Acidifcation	(SO_x, NO_x, NH_3) emissions	Deposition; concentrations	Investments; signed agreements
Toxic contamination	(POC, heavy metal) emissions	(POC, heavy metal) concentrations	Recovery hazardous waste; investments/costs
Biodiversity	Human uses esp. fishing	Species abundance compared to pristine area	Protected areas
Fish resources	Fishing effort	Sustainable stock levels	Quotas
Oceans/Coastal Zones	Emissions, oil spills, depositions	Water quality	Coastal zone management; ocean zoning
Environmental index	Pressure index	State index	Response index

Table 1.2: Illustrative matrix of environmental indicators (adapted from OECD and UNEP in Hammond et al., 1995)

1.19 There are several variations on this approach, including the DPSIR framework adopted by the European Environment Agency (EEA), where **D = Drivers** (human activities) lead to **P = Pressures** (emissions, fish captures), that change **S = State** (of the environment), and result in **I = Impacts** (pollution, health related issues, erosion). Such impacts are counteracted by **R = Responses** (policy, conventions, regulations), which aim to control/act on Drivers (EEA, 2005; IOC, 2006). The DPSIR framework informed the structure of the World Ocean Assessment (see Chapter 2) and is illustrated in Figure 1.2[1].

[1] More information on State Indicators is set out in Chapter 4 [2]

Environment can be defined simply as “what surrounds us”.

[3] It should be noted that the number of countries covered in the Programme does not necessarily correspond with

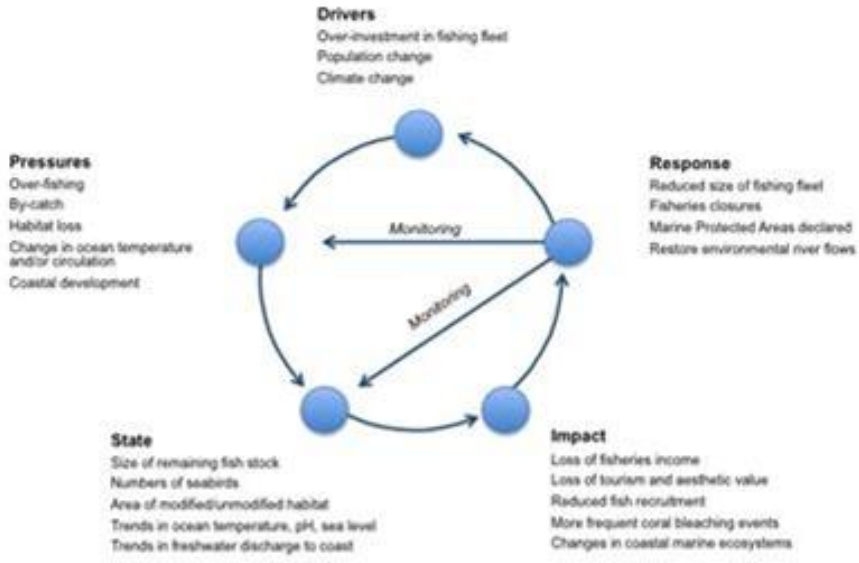

Figure 1.2: Diagram illustrating the DPSIR framework. Source : WOA (2013)

1.20 A credible alternative is the Global International Waters Assessment (GIWA) Assessment Protocol, a methodological approach for conducting causal chain analyses for use in transboundary diagnostic analyses. This has been used by the Global Environment Facility (GEF) as the principal mechanism for defining Strategic Action Programmes (SAPs). The methodology traces back issues and concerns that are observed symptoms of a causal effect and links them to their root cause. Immediate variables (physical, biological and chemical) are related to sectoral causes reflecting socio-economic, political-legal and cultural factors. Root causes may be institutional, capacity-related or reflective of conflicting or misplaced incentives (Belausteguigoitia, 2004; UNEP, 2005a).

1.21 A combination of frameworks may also be useful, since one single framework may not be enough to identify the best combination of indicators for a particular process (IOC, 2006). The most desirable indicators (e.g. in terms of sensitivity) might not always be the most operationally useful. This can lead to the choice of less sensitive indicators that are reliable and for which acceptable and unacceptable limits are known. In all cases an understanding of different linkages (e.g. between pressure and state) is essential to achieving operational objectives. Quite often, governance and socioeconomic indicators are given preference/precedence over ecological indicators: some aspects of governance and socioeconomic outcomes of management initiatives are easier to pinpoint, and their measurement is faster and more straightforward than the measurement of the much more complex and slower responses of ecological systems to management efforts.

1.22 Ultimately, however, humans depend on the oceans, seas and coasts (CEC 2007; Pew Oceans Commission, 2003; UNEP 2011b). Not only that, as vividly demonstrated by fisheries crisis worldwide, “the health of ecosystems (…) directly affects the health of economies and societies” (IOC, 2006, p.40). As such, the evaluation of governance and socioeconomic aspects in the management of human actions on the ocean, must, in itself, include an evaluation of environmental and ecological

conditions and trends - ultimately of ecosystem health. Several types of indicators have been used to measure ecosystem health.

Environmental indicators

1.23 Different types of environmental[2] indicators have been identified depending on what is being measured as shown in Table 1.3.

Type	Indicators	Measures
A	Descriptive 'What is happening?'	Trends
B	Performance 'Are we reaching targets?'	The distance between current situation to desired situation
C	Efficiency 'Is there improvement?'	The relationship between drivers and pressures in order to look for change (positive or negative)
D	Policy effectiveness 'Are measures working?'	Identifies actual change of environmental variables in response to policy efforts
E	Welfare 'Are we better off?'	Identifies the balance between economic, social and environmental development

Table 1.3: Types of environmental indicators (Based on Stanners et al., 2007)

Ecosystem-based indicators

1.24 The ecosystem is the functional building block of ecological systems (as the cell is the building block of life). It includes the biotic (living) community and the non-living environment that supports it. Many of the interactive processes critical to all life take place at the ecosystem level. Large ecosystems, to which ecosystem-based management applies, correspond at least roughly to biogeographical units. Ecosystem-based indicators therefore relate to the environmental 'health' of a region as a whole (resilience, structure and vigour) as affected by a range of human interactions. A pre-requisite for ecosystem-based indicators is that they relate to spatially referenced data and/or policies for a particular region or ecosystem. Ecosystem-based indicators are, for example, at the core of the Ecological Quality Objectives (EQO) system developed by the OSPAR Commission to obtain an overall picture of the state of the marine environment. The rationale of this system is:

1st - to identify ecosystem components that reflect high ecological quality (e.g. seabirds);

2nd - to identify human impacts on this component and how they can be monitored (e.g. oiled marine birds found dead or dying on beaches) (ecological element or ecosystem-based indicator); and

[2] Environment can be defined simply as "what surrounds us".

3rd - Taking into account existing policies, define objectives/limits (e.g. max. proportion of such birds found in such conditions, in a given area) (ecological quality objectives).

Ecosystem service indicators

1.25 An emerging consideration is the attention now being given to define and measure ecosystem services and their functioning. Ecosystem services (e.g. food, fuel, air production, climate regulation, water purification, i.a.) are "the benefits human populations derive, directly or indirectly, from ecosystem functions" (Costanza et al 1997, p.253). These benefits are provided by nature at no cost to humans. However, human use of these services is rapidly contributing to deteriorate ecosystem health. The consideration of ecosystem services represents a step higher in the ladder of integrative/systems' thinking of ecosystem-based management.

1.26 Inter-governmental efforts to assess ecosystem services status and trends are being led by the Convention on Biological Diversity (CBD) linked to the Aichi targets (cf. Chapter 6) contained within the CBD Strategic Plan (2011-2020) as well as the emerging Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES).

1.27 A common challenge is the choice of ecosystem services to assess informed by indicators as determined by policy objectives and data availability. This is further complicated by the need to establish not only the integrity of the ecosystem (to provide services) but also the benefits derived from the ecosystem services concerned. However, the language is different, identifying indicators for provisioning services (e.g. food, biomass fuel), regulating services (e.g. climate regulation, water purification) and cultural services (e.g. tourism and recreation), drawing upon linkages set out in the Millennium Ecosystem Assessment conceptual framework (MEA, 2005) and followed-up by The Economics of Ecosystems and Biodiversity initiative (TEEB, 2010).

1.28 Currently this topic is the subject of further research (methodologies, metrics and data sources), thus uncertainty remains regarding how these indicators will be taken forward and/or integrated with other frameworks. Recommendations from a review of relevant sub-global assessments (UNEP-WCMC, 2011) included encouragement to adopt a small set of specific, policyrelevant indicators; utilize existing data and proxies; and monitor multiple services over time allowing for a better understanding of synergies and trade-offs. Geographic scale is another factor for consideration as indicators applicable at the national or regional scale may not be aggregated into or disaggregated from global datasets.

Summary

1.29 Indicators can provide information to guide sustainable management. Ecosystem-based indicators can apply both to the state of the marine environment and to considerations of performance against environmental targets and/or limits in a defined geographical area. In order to guide management, indicators should be set within a reference framework and hierarchies of indicators can provide coordinated support. In time, current ecosystem-based indicators are likely to embrace ecosystem service indicators, and synergies should be considered when envisaging any relevant strategic development.

2. Regional application of the Ecosystem Approach

2.1 The concept of an ecosystem approach and its relevance to Regional Seas Conventions and Action Plans was discussed at the 14th Global Meeting of the Regional Seas and Action Plans held in October 2012 (UNEP (DEPI)/RS.14/WP.2.RS). This chapter introduces the ecosystem approach and its application by several organisations and initiatives that carry out indicator-based assessment in a regional context. The intention is to provide context for later discussion on the use of assessment of state of the marine environment and monitoring of progress in achieving ecological objectives or targets.

Defining the Ecosystem Approach

2.2 The Ecosystem Approach (and a range of synonymous terms such as ecosystem-based management) is a conceptual framework incorporating human activities undertaken at sustainable levels as an accepted element of ecosystem functioning. Seen as a paradigm shift away from highly focused short-term sector-by-sector resource assessment, it origins date back to management applied to the Great Lakes Basin Ecosystem in the 1970s (Sherman and Duda, 1999). Emphasis is placed on balancing environmental elements and equity, recognizing that ecosystem health relies on key interactions and accepting that ecosystems are resilient but have thresholds or tipping points.

2.3 Inspired by the 1992 Earth Summit and Agenda 21, the Ecosystem Approach has become the primary implementation framework of the Convention on Biological Diversity (CBD) defined as 'a strategy for the integrated management of land, water and living resources that promotes conservation and sustainable use in an equitable way' and based on the CBD definition of an ecosystem set out in Article 2 of the Convention as 'a dynamic complex of plant, animal and micro-organism communities and their non-living environment interacting as a functional unit' (CBD, 2013a). Elaborated explanations promote the framework as the basis of 'an adaptive management strategy recognizing that ecosystem processes are often non-linear, fluctuate spatially and temporally and frequently show time lags creating a high level of uncertainty' (JNCC, 2013).

2.4 As an outcome of the World Summit on Sustainable Development in 2002, the Johannesburg Plan of Implementation associated the Ecosystem Approach with integrated coastal management. It was recognized that sectoral approaches have not yielded the progress needed to protect and restore marine ecosystems and enhance livelihood security. Subsequently the UN General Assembly and associated processes have continued to promote and apply this in a marine context (UNDOALOS, 2010). Thus the Ecosystem Approach continues to underpin the latest policy initiatives including the CBD Strategic Plan for Biodiversity 2011-2020 and its Aichi Biodiversity Targets (2010, Decision X/2, COP10)(CBD, 2010); the UNEP Marine and Coastal Strategy (UNEP, 2011c); the Rio+20 outcome document (UNCSD, 2012a); and the UN Ocean Compact (UNDOALOS, 2012).

2.5 The Millennium Ecosystem Assessment undertaken in 2005 was influential in making explicit the link between status of natural resource systems and ecosystem services. Interdependent interactions between ecosystems and social, economic and cultural factors are acknowledged. Thus, impacts of human activities are recognized as a matter of social choice and a key objective is to ensure that governance mechanisms balance use of natural resources with their conservation, a focus more on integrity of the ecosystem and less on site-based approaches or on recovering target species. Tradeoffs between management priorities for different ecosystem services must be made transparent and explicit, requiring involvement of all stakeholders and a clear understanding of desired ecosystem health or status.

2.6 In developing a European Marine Strategy, the European Union specifically placed humans as part of natural ecosystems, defining the Ecosystem Approach as 'a comprehensive integrated management of human activities based on the best available scientific knowledge about the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of the marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity' (ICES, 2005 p.4).

2.7 Murawski (2007) argued that ecosystem approaches to marine management are emerging as best practice. However, it is still unclear what kind of governance structure and institutions are most capable of delivering the Ecosystem Approach and sustaining flows of ecosystem services in the longer term (POST, 2011).

Application of the Ecosystem Approach to regions

2.8 Considerable thought was given to applying the Ecosystem Approach at a regional scale in the context of developing the EU Marine Strategy Framework Directive (MSFD). Setting out guidance for a seven-step process, ICES (2005) emphasized that:

1. As a framework embedded in the concept of sustainable development, implementation of the Ecosystem Approach should take into account:
   - linkages between the terrestrial and marine environment;
   - environmental variation and natural change; and
   - long-term perspectives.

2. Ecological objectives to protect ecosystem structure and function, and associated operational objectives, should be set on geographical scales comparable with economic and social objectives.

3. Appropriate management regions should be dictated by biogeographic and oceanographic characteristics whilst taking into account existing political, social and economic divisions.

4. A coordinated system of objectives, indicators, limits and targets (as described in Chapter 1) is needed; and

5. Management tools to achieve adaptive management include input controls, output controls, spatial and temporal distribution controls, integrated planning tools, remediation tools, and economic incentives.

2.9 The seven-step process proposed (as summarized in Table 2.1), effectively a variation on the standard cyclical environmental management system, was transposed into the MSFD and incorporates the derivation of operational objectives with indicators and reference points as a constituent element or step within that system.

Step	Description
1	**Scoping the current situation**: evaluate status, relevant policy context, an inventory of human activities and relevant economic and social policies
2	**Contrasting with the vision**: identify discrepancies between vision and current status
3	**Identifying important ecosystem properties and threats**: cross tabulation of ecosystem properties and components with major human activities impacting on the ecosystem
4	**Setting ecological objectives**: adequate coverage of valued ecosystem components and threats, as well as inter-compatibility and compatibility with social and economic objectives
5	**Deriving operational objectives with indicators and reference points**: assemble an appropriate suite and relate to the 'vision'
6	**Ongoing management**: apply management tools, monitor and assess
7	**Periodic updates**: re-evaluate to account for environmental change and changing societal needs

Table 2.1: Seven steps to apply the Ecosystem Approach at a regional scale (adapted from ICES, 2005)

2.10 Key marine regional and global governance initiatives using and developing indicators and indices are set out below.

Regional Seas Programme (RSP)

2.11 Launched in 1974 with a remit to address the accelerating degradation of the world's oceans a total of 18 Regional Seas Conventions and Action Plans across the world provide a legal framework and reflect political will for coordinated action to tackle common marine environmental issues. Of these 13 are established under UNEP auspices and 5 are partner Programmes (see Table 2.2). Some are more 'mature' than others with reference to their use and adoption of indicators for assessment and monitoring.

RSCAP	Convention	Year adopted	Year entered into force	No. of States[3]
1.Mediterranean	Barcelona	1976/1995	1978/2004	22
2. ROPME[4] Sea Area	Kuwait	1978	1979	8

[3] It should be noted that the number of countries covered in the Programme does not necessarily correspond with the number of countries that have ratified the respective Conventions.

3. Western and Central Africa	Abidjan	1981	1984	29
4. South-East Pacific	Lima	1981	1986	4
5. Red Sea and Gulf of Aden	Jeddah	1982	1985	8
6. Wider Caribbean	Cartagena	1983	1986	28
7.Eastern Africa	Nairobi	1985	1996	10
8.South Pacific	Noumea	1986	1990	19
9.Black Sea	Bucharest	1992	1994	6
10.North-East Pacific	Antigua	2002	Action plan in force	8
11.East Asian Seas	None	1984 (Revised in 1993)	Action plan in force	9
12. North-West Pacific	None	1994	Action plan in force	4
13. South Asian Seas	None	1995	Action plan in force	5
14. Baltic Sea	Helsinki	1974/1992	1980/2000	10
15. North-East Atlantic	Oslo-Paris (OSPAR)	1974/78/92	1998	16
16. Antarctic	Antarctic Treaty/CCAMLR [5]	1959/1980	1961/1982	32
17. Caspian Sea	Tehran	2003	Not in force	5
18. Arctic/PAME	None but Arctic Council working group(s)			8

Table 2.2: Summary of the Regional Seas Programme and implementing Conventions (1-13 UNEP auspices, 14-18 Partners)

2.12 For those entities within the RSP, joint coordination is generally engendered through an Action Plan, or collectively agreed Strategy, which for most is legally underpinned by a regional Convention and associated Protocols (or Annexes). Thus whilst each Regional Seas Convention and Action Plan (RSCAP) is part of a common global family with a collective mandate, and each is ratified by relevant States or in the case of some adopted Action Plans recognized by States as a soft legal instrument, their work programmes and approaches to management are based upon the region's particular environmental concerns and challenges as well as its socio-economic and political situation (UNEP,

[4] The Regional Organisation for the Protection of the Marine Environment Sea Area covers 8 states that joined together in 1978 to adopt the Kuwait Regional Convention for Cooperation on the Protection of the Marine Environment from Pollution, otherwise known as the Kuwait Convention and 4 associated Protocols.

[5] The Commission for the Conservation of Antarctic Living Resources (www.ccamlr.org)

2005b). Evaluations of the Regional seas experience (e.g. Rochette and Chabason, 2011) highlight significant achievements, but also place emphasis on differences between regional arrangements and variations resulting from intrinsic limitations reflecting fragmented international governance (for example in all regions the International Maritime Organisation is the competent organization for regulation of international shipping but in some regions the pressure and volume of shipping traffic merits specific regional attention). The latter has fuelled calls for an improved global legal regime as well as the expansion of existing and new regional agreements and mandates for managing the high seas (e.g. Ban et al., 2013).

2.13 Successive efforts to set common Strategic Directions for the Regional Seas Programme (2004-2007, 2008-2012, 2013-2016) have recognized the value of an action-orientated approach to common integrated priorities based on an ecosystem approach. Most RSCAPs have undertaken trans-boundary diagnostic assessments and some prepared strategic action programmes. Most also carry out regular assessments of the state of the marine environment and issue state of the regional marine environment reports.

2.14 However, the differing levels of implementation of individual regional Action Plans (reflecting variation in governance arrangements, funding, activity and influence) have so far not been systematically centrally monitored to indicate the level of achievement of the implementation of Action Plans in different regions. Thus there is a need for enhanced result-based monitoring and evaluation of policies, programmes and projects based on measurable indicators of success. The ecosystembased approach, object and target setting and associated monitoring are inter-related. As explained in Chapter 1 any management response (and its effectiveness as measured by the status of Action Plan implementation) can form part of an indicator-based assessment package.

2.15 Each set of Strategic Directions has emphasized the need to take up and adopt an Ecosystem Approach but UNEP has recognized barriers present in some current arrangements (see Table 2.3).

Common elements of an Ecosystem Approach at the regional level
Geographical coverage respects ecological functions and continuity as well as political boundaries
Assessment considers all ecosystem processes and functions including human socioeconomic activities
Optimal use of ecosystem goods and services is combined with equitable benefit sharing
Sources of stress and threats are addressed to maintain ecosystem integrity
Barriers to introduction of an Ecosystem Approach at the regional level
Political considerations determine geographic coverage
Failure to identify drivers for ecosystem change
Lack of integration with governance of key sectors (e.g. fisheries)
A focus on normative action rather than pollution sources and threats to ecosystem functioning

Table 2.3: Ecosystem Approach common elements and barriers (adapted from UNEP 2012)

Global Environment Facility Large Marine Ecosystem Projects (GEF-LMEs)

2.16 The world's 64 LMEs as defined by the US National Oceanic and Atmospheric Administration (NOAA) are discrete marine areas (typically about 200,000km2) identified by ecological criteria (bathymetry, hydrography, productivity and trophic relationships) adjacent to the continents in coastal waters (Sherman and Hempel, 2008). Collectively countries sharing an LME can consider the root causes of degradation of their coastal areas and contributing basins and the need to integrate changes in sectoral economic activities (Duda and Sherman, 2002). The Global Environment Facility (GEF) is a funding agency assisting developing coastal countries to meet ecosystem-related targets. GEF recommends the use of LMEs as the geographic focus for ecosystem-based strategies to reduce coastal pollution, restore damaged habitats, and recover depleted fisheries. Within the marine and coastal portfolio of the International Waters focal area of GEF there are currently 18 GEF-LME Projects.

2.17 In a GEF-LME project funding is typically linked to development of a Transboundary Diagnostic Analysis (TDA) and a Strategic Action Plan (SAP). The latter is negotiated with the intention of creating the enabling conditions and prioritising Project actions to remedy issues identified in the TDA. The process establishes Project goals and milestones having identified the driving forces of ecosystem change. The LME approach uses the NOAA 5-module suite of ecosystem condition indicators (productivity, fish and fisheries, pollution and ecosystem health, socioeconomics, governance) to provide the scientific and economics foundation for management actions as shown in Figure 2.1 (for more details see Sherman and Duda, 1999). Establishment of a baseline condition against which to measure the success or failure of management actions is stressed as a prerequisite.

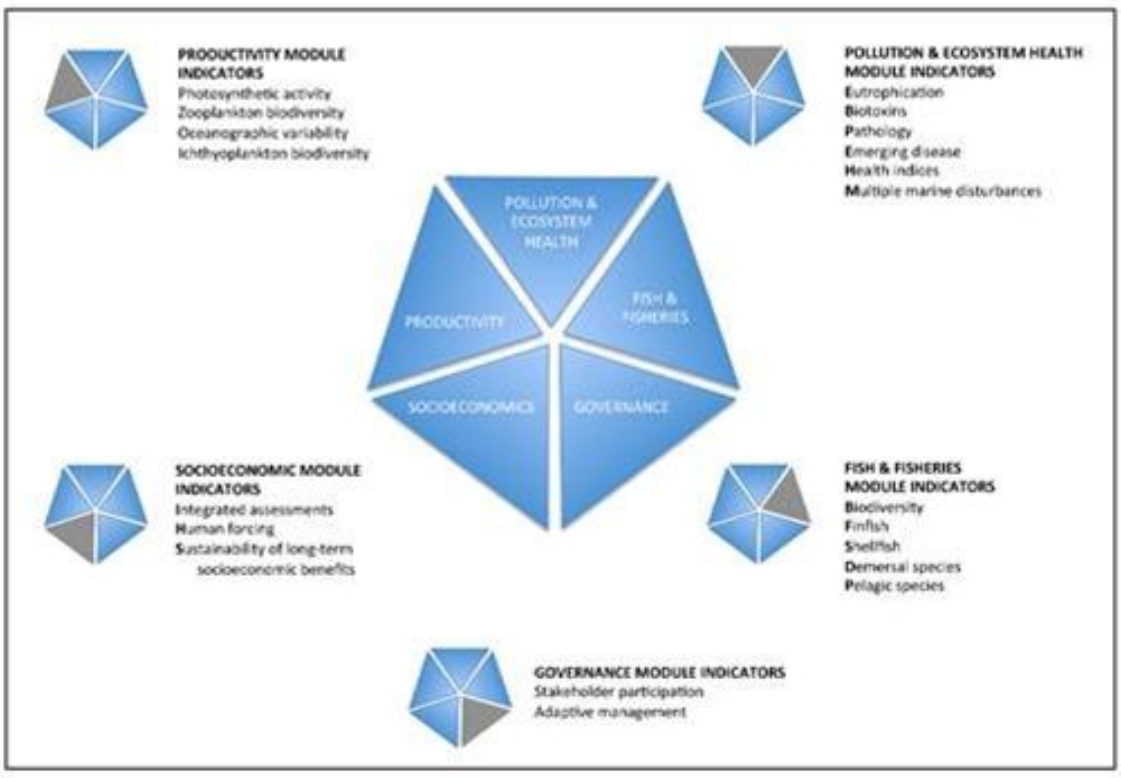

Figure 2.1: LME 5-module model for sustainable development (Sherman and Hempel, 2008 p.8)

2.18 Linkages between the 5 LME Modules and the TDA/SAP processes are shown in Table 2.4. The intention of the GEF-LME Projects is ultimately to create an adaptive, self-financing, management regime for LMEs located within or in relation to Regional Seas areas[6]. Periodic assessments (TDA updates) are envisaged. The assessment and management cycle fosters an adaptive management approach by establishing monitoring and evaluation indicators. However, GEF funding was always intended as a catalytic means to address degradation of coastal waters in developing countries and the long-term viability of GEF Projects is uncertain.

LME Module	TDA	SAP
1. Productivity	Transboundary issue, identify threats and root causes	Regional and national reforms to maintain productivity
2. Fish resources and Fisheries	Transboundary issue, identify threats and root causes	Regional and national reforms to sustain fisheries
3. Pollution and Ecosystem Health	Transboundary issue, identify threats and root causes	Regional and national reforms to reduce pollution and sustain ecosystem
4. Socioeconomics	Socioeconomic impact analysis, including prioritization of issues	Economic instruments, investments etc., as tools for SAP implementation
5. Governance	Governance analysis, stakeholder analysis	Legal, policy and institutional reforms; ministerial level adoption; stakeholder involvement (private sector and civil society)

Table 2.4: Linkages between 5 LME Modules and TDA/SAP processes (Olsen et al., 2006)

2.19 Olsen (2003) developed a framework suggesting 'sets of indicators to trace the evolution of an LME management system as it progresses from the baseline conditions documented by the TDA to (hopefully) progressively more sustainable conditions and patterns of use' (Olsen et al., 2006 p.27). Four sets of indicators identified were i) indicators serving as markers for the preconditions needed for ecosystem-based management; ii) stress reduction indicators; iii) environmental status indicators; and iv) indicators showing a dynamic equilibrium between both social and environmental qualities.

Global marine policy initiatives with regional dimensions using indicators

2.20 A number of marine policy initiatives initiated at the global level as a response to internationally agreed obligations have given consideration to the use of indicators or may influence indicator development as follows:

1. The World Ocean Assessment (Regular Process for Global Reporting and Assessment of the State of the Marine Environment Including Socioeconomic Aspects, UNGA resolution 64/71):

[6] Some of the LMEs, such as the Somali Current LME, cover geographic areas outside the Regional Seas Programme geographic boundaries

is compiling existing information from regional and sub-regional state of the environment assessments (assessments listed in the GRAME database) to provide a baseline against which it is expected regular chronological assessments will take place. In December 2010, the United Nations General Assembly (resolution 65/37, paragraph 209) established a Group of Experts to produce the first World Ocean Assessment by 2014 (under the supervision of the Ad Hoc Working Group of the Whole). A series of regional workshops are being held as a means of identifying regional expertise, collating an inventory of existing assessments and building capacity for integrated assessment, with the aim of securing coherence, consistency and comparability (to date these have covered the Eastern Pacific Ocean, East Asia Seas, North Atlantic/Baltic/Mediterranean/Black Sea, Wider Caribbean, Western Indian ocean and South-West pacific (UNDOALOS, 2013)). In advance of scaling up existing assessments the Group of Experts will take account of:

a. types of data, experiential knowledge, indicators and the reasons for their selection;
b. trends and methods used;
c. integration methods;
d. sources of any evaluation benchmarks, reference levels or ecotoxicological assessment criteria;
e. extent and sources of any forecasts, projections and scenarios
f. data assessment limitations (e.g. data-extrapolation errors, uncertainties and/or information gaps)

At a global scale the World Ocean Assessment seeks to address fundamental questions relevant to ecosystem-based indicators and indices, namely:

a. what is the overall state of the world's oceans and seas?
b. are marine ecosystems around the world improving or declining?
c. What benefits do we get from the world's oceans and seas, how are they distributed?
d. How can we measure the state of the oceans and seas? And what threatens them?

The World Ocean Assessment started from a DPSIR systems-analysis view (UNEP, IOCUNESCO, 2009) with the Group of Experts deciding on a combination of pressures, marine habitats and ecosystem services as the basis for its structure.

2. The Global Coral Reef Monitoring Network (GCRMN): supports the International Coral Reef Initiative to document the status and trends of coral reefs around the world. The aim is to enhance scientific understanding by linking biophysical monitoring with social, economic and environmental data. Status reports present global (Wilkinson, 2008) and regional analyses (Chin et al., 2011) of patterns and processes based on available data sets consider temporal trends (percentage cover, density) and multivariate analyses to examine intra-regional differences (e.g. coral trajectories within and among individual coral taxa). Work is frustrated by the lack of a universal standard for monitoring. However, in addition to the status reports, based on the success of the 2012 Tropical Americas Coral Reef Resilience Workshop in the Caribbean (ICRI, 2012), GCRMN is embarking on similar resilience evaluations in all regional seas where coral occurs (Australia and Melanesia, Coral triangle and East Asia, North Pacific and South Pacific, Indian Ocean and Red Sea) to achieve a global synthesis report.

3. The Transboundary Waters Assessment Programme (TWAP): is directed at the most serious global water issues, using indicators as a tracking tool to assess the impact of interventions and to provide a means for more effective use of resources in addressing transboundary concerns and conflicts between countries. TWAP defines five categories of transboundary water systems - aquifers, lakes / reservoir basins, river basins, LMEs and open ocean. The marine modules designed for assessment of LMEs (module 5) and Open Ocean (module 6) provide a possible framework (IW: LEARN, 2009). The development of these methodologies

(see Chapter 5, Case Study 5) is currently being taken forward (2013-2015) to produce a global assessment of LMEs based on key indicators.

4. Rio+20 Sustainable Development Goals (SDGs): are under development with discussion about which indicators might measure their achievements. Agreement to develop a set of SDGs was one of the main outcomes of Rio+20 and is intended to converge with the post 2015 development agenda as summarized on the UN Sustainable Development Knowledge Platform (UN DESA, 2013). A 30-member Open Working Group is preparing a proposal. Current ideas on SDGs and indicators have been summarized by the UNCSD Secretariat and are explored further in Chapter 6 of this report. Attention is being given to the CSD indicators, originally developed on the basis of the pressure-state-response model, that currently contains a core set of 50 indicators as part of a larger set of 96 indicators of sustainable development (UNDESA, 2007) with an acknowledgement that many other indices exist as developed by UN-entities, Foundations and civil society (e.g. OECD Green Growth indicators). It has been suggested that there is merit in using an internationally agreed statistically framework, such as the SEEA developed by the UN Committee of Experts on Environmental Accounting, as the basis for indicators.

Related initiatives

2.21 The above initiatives have not proposed a comprehensive measure covering ocean systems and internal ocean interactions. However, two recent initiatives have been proposed as solutions for assessing the state of the human-ocean system.

2.22 The Ocean Health Index (OHI) presents an average of 10 human goal scores to evaluate the condition of marine ecosystems for each Exclusive Economic Zone (EEZ) for 171 States (Halpern et al., 2012a and 2012b). Calculating the OHI is explained in relation to present status based on a reference point and future trend as influenced by pressures and resilience. These different dimensions (status, trend, pressure, resilience) are informed by components (e.g. total counts of alien species according to data from the Global Invasive Species Database). The issues covered by the 10 human goals overlap significantly with those promoted by the Global Ocean Partnership for Oceans (an alliance of governments, international organisations, civil society groups and private sector interests) as essential to tackle (Global Partnership for Oceans, 2013).

2.23 The Environmental Vulnerability Index (EVI) has been developed by the South Pacific Applied Geoscience Commission, UNEP and the Secretariat of the Pacific Community. It is designed as a rapid and standardized method to assess sustainable development progress and to be used with economic and social indices. The specific focus is on (and for) small island developing States in response to the Barbados Programme of Action (Section C5: 113-114). The EVI uses 50 'smart' indicators, classified into types (weather and climate, geology, geography, resources and services, human populations), aspects (e.g. hazards) and a range of sub-indices (EVI, 2013). Whilst not specifically marine, this synthesis framework groups countries according to five vulnerability classification (from extremely vulnerable to resilient).

Lessons from another Biome

2.24 Marine regions (oceans and estuaries) within the Aquatic Biome are not alone when considering the relevance of ecosystem-based indicators. Sustainable forest management has been promoted through negotiation of an integrated global framework in the form of a non-legally binding instrument (UN A/Res/62/98) in the context of four Global Objectives on Forests, with seven clear cut

thematic clusters of sustainable development. This 'Forest Instrument' has required the development of a streamlined reporting format and consideration of a set of indicators that are objective, reliable and feasible to report on. FAO has been working on identifying the most appropriate indicators for its 2015 Forest Resources Assessment. In 2011 a streamlined draft format (for national reporting), based on a questionnaire with a core set of indicators, in the form of a template was developed by the United Nations Forum on Forests (UNFF)[7], subsequently supported by a series of five regional capacity building workshops for Forest Resources Assessment focal points. UNFF has an 8-year (2007-2015) Multi-Year Programme of Work (MYPOW) and biennial sessions with the next meeting 2015 (UNFF 11) that should receive national reports based on qualitative and quantitative indicators. Attention has been given to use of indicators from on-going criteria and indicator processes (e.g. FAO Forest resource Assessment; UN Millenium Development Goals; ITTO criteria and indicator process; CBD indicators) and the need for additional indicators as these on-going processes are not comprehensive in addressing the Forest Instrument and its Global Objectives and the special theme of UNFF 11.

2.25 Developing the indicator suite is an on-going iterative process. The following text drawn from page 14 of the report of the 4th capacity building Workshop, held before UNFF 10 in April 2013, explains the breakdown of indicators that were under consideration at that time (Illueca, pers.com, 2013)

'The proposed questionnaire/template contains a combined total of 93 points of information (indicators) is requested for UNFF 10. Of these, 78 form the core reporting for both Forum sessions, with the remaining 15 specific to the overall theme of UNFF 10 on forests and economic development. Of the 78 core indicators, 25 are indicators from the on-going FRA and ITTO criteria and indicators processes that can be pre-filled for countries. Three are MDG indicators, of which two can be pre-filled for countries. The remaining 50 new indicators consist of 10 MDG indicators that have been adjusted to focus on the livelihoods of forest dependent people and 40 that are additional questions that are primarily of a yes-or-no, multiple choice nature, with some requesting quantitative information primarily related to Global Objective 4 on forest financing. In other words, 64% of the questionnaire/template is requesting information outside existing C & I processes, with most requiring simple yes-or-no and multiple-choice responses. If the quantitative information requested is not available, countries are asked to respond NA. One question asks governments to rate the effectiveness of forest financing. For 14 strategic questions in the core reporting, governments are provided the opportunity to present 250-500 words of text elaborating on each response (mainly yes responses)'.

Summary

2.26 The Ecosystem Approach is widely accepted in international and national policy as a valuable framework to guide the sustainable development of marine and coastal ecosystems. In addition to factoring in human activities and social choices more emphasis is placed on integrity of the ecosystem than previous site-based and/or target species approaches to conservation. Application of the Ecosystem Approach to marine regions relies on establishing a coordinated system of ecological and operational objectives, informed by indicators, limits and targets. Such applications have been implemented in the marine context with varying success by UNEP RSP, GEF-LME Projects and a number of global initiatives with regional dimensions. A better understanding of which indicators are being used, and their utility in demonstrating application of the Ecosystem Approach at the regional scale, would help make more explicit the value of regional entities and strengthen arguments to support their work. Furthermore it makes sense to avoid duplication. Regional indices should ideally

[7] UNFF is the UN's principal forest policy making body

nest within and feed global initiatives established to measure environmental condition or change (these range between using 4 - 260 indicators) with the intention of reporting on sustainable development progress and/or state of the environment. Lessons can be learned from the on-going development of indicators and a reporting mechanism for monitoring and evaluation of implementation of the UN Forest Instrument.

3. The purpose and remit of this study

3.1 At a time when ocean governance is coming under increasing scrutiny it is appropriate to consider how best to align regional initiatives with international developments and reflect on the appropriate level of commonality between measurements of the effectiveness of regional entities. Previous chapters in this report have considered the evolution of related considerations and developed a clear rationale as to why the examination of regional ecosystem-based indicators is needed. The aim and objectives of this report are set out below together with the methodology adopted upon which conclusions are drawn and recommendations proposed.

Aim and objectives

3.2 The aim of this report is to consider the relevance of a set of indicators capable of comparing a number of common regional marine ecosystem issues and major sources of stress and threats to the functioning of those ecosystems. The intention is to elicit a standardized approach that is both repeatable in different regions and over time (i.e. one that would also input to comparative global assessments as currently envisaged on a periodic basis).

3.3 The objectives of this report are to explore:

a) If it is feasible for regional organisations to agree to adopt and monitor a common set of indicators and indices (a so-called 'coordinated set'), with the possibility of developing a future associated sub-set of suggested parameters. If so how would this relate to global indices in operation or currently under design?
b) Whether the indicators and indices being monitored by regional entities are sufficiently linked to the goals and objectives they have set themselves or those which have been set globally?
c) How the indicators and indices differ between those used to track down the state of the marine environment and those to gauge success against marine environmental performance targets?

3.4 In order to meet these objectives the report therefore aims:

a) To collect and collate information on the marine ecosystem-based indicators and indices currently being measured by regional entities for the purposes of state of the environment reporting and tracking down the achievements of regionally agreed, ecosystem-based objectives and targets;
b) To analyse these indicators to find common elements to be used for continuing regional state of the environment reporting in order to formulate recommendations to the ongoing discussion on the global state of the environment reporting; and
c) To scope a generic set and/or sub-set of indicators, with associated scientific background that the UNEP Regional Seas Programme (RSP) may consider adopting. In this way the report is also intended as a contribution to future direction setting for the RSP.

Methodology

3.5 Initial consideration was given to 'which regions' - ecoregions, RSCAPs, LMEs, global ocean assessment regions, regions comprising EEZs of groups of States - should be examined for their use of marine ecosystem-based indicators.

3.6 Marine 'ecoregions' based on biogeographic characteristics have been defined by Spalding et al. (2007 p575) as 'areas of relatively homogeneous species composition, clearly distinct from adjacent systems" dominated by "a small number of ecosystems and/or a distinct suite of oceanographic or topographic features'. The Marine Ecoregions of the World (MEOW) classification, developed within the Census of Marine Life (CoML, 2010), identifies 232 marine ecoregions nested into 62 provinces which in turn fit into 12 major realms. Both RSCAPs and LMEs have been determined partly on a biogeographic basis but influenced by administrative (practical) and political considerations. The regions adopted for the Global Ocean Assessment are much larger and more like MEOW realms.

3.7 Entities/target programmes to be researched for this study include the Regional Seas Programme, GEF-LME projects in operation and key global marine assessment programmes with regional dimensions (see Chapter 2). As the report's main objective is to provide recommendations for regional seas in setting core and their specific indicators, the information collection targeted the 18 regional seas programmes under the UNEP Regional Seas Programme as well as the GEF funded regional marine projects were Startegic Action Programmes were adopted in which the regional state of the marine environment reporting and regional management objectives/goals are described. Specifically therefore information was sought from:

REGION / SEA	ORGANISATION / PROJECT	ACRONYM*	WWW ADDRESS
Northwest Pacific	Northwest Pacific Action Plan	NOWPAP	http://www.nowpap.org/
Black Sea	Black Sea Commission	BSC	http://www.blacksea-commission.org/
Red Sea and Gulf of Aden	The Regional Organization for the Conservation of the Environment of the Red Sea & Gulf of Aden	PERSGA	http://www.persga.org/
ROPME Sea Area (RSA)	Regional Organization for the Protection of the Marine Environment	ROPME	http://ropme.org/home.clx
South Pacific	Secretariat of the Pacific Regional Environment Programme	SPREP	http://www.sprep.org/
Antarctic	Commission for the Conservation of Antarctic Marine Living Resources	CCAMLR	http://www.ccamlr.org/
Caribbean	Caribbean Large Marine Ecosystem Project	CLME	http://www.clmeproject.org/
Baltic Sea	Helsinki Commission	HELCOM	http://www.helcom.fi/
Bay of Bengal	Bay of Bengal Large Marine Ecosystem Project	BOBLME	http://www.boblme.org/
South China Sea	South China Sea Project	SCS	http://www.unepscs.org/
East and Southern Africa	Nairobi Convention		http://www.unep.org/nairobiconvention/
Agulhas and Somali Currents	Agulhas and Somali Currents Large Marine Ecosystem Project	ASCLME	http://www.asclme.org/
South Asian Seas	South Asian Cooperative	SASP	http://www.sacep.org/html/s

Programme	Environment Programme		as.htm
Wider Caribbean	The Caribbean Environment Programme	CEP	http://www.cep.unep.org/
South East Pacific	Comisión Permanente del Pacifico Sur	CPPS	http://www.cpps-int.org/
North East Atlantic	OSPAR Commission	OSPAR	http://www.ospar.org/
East Asia	Partnerships in Environmental Management for the Seas of East Asia	PEMSEA	http://www.pemsea.org/
Arafura-Timor Seas	Arafura and Timor Seas Action Plan	ATSEA	http://www.atsea-program.org/
Humboldt Current	Towards Ecosystem Management of the Humboldt Current Large Marine Ecosystem	HCLME	http://humboldt.iwlearn.org/
Mediterranean	Mediterranean Action Plan	MAP	http://www.unepmap.org/
West and Central Africa	Abidjan Convention	WACAF	http://abidjanconvention.org/ /
Benguela Current	Benguela Current Commission	BCLME	http://www.benguelacc.org/
Guinea Current	Guinea Current Large Marine Ecosystem Project	GCLME	http://gclme.iwlearn.org/
Gulf of Mexico	Integrated Assessment and Management of the Gulf of Mexico Large Marine Ecosystem	GOMLME	http://gomlme.iwlearn.org/en
Yellow Sea	UNDP/GEF Yellow Sea Large Marine Ecosystem Project	YSLME	http://www.yslme.org/
Arctic	Arctic Council		http://www.arctic-council.org/index.php/en/
Celebes-Sulu-Sulawesi Seas	Celebes-Sulu-Sulawesi LME		
*Acronym used within this study			

Table 3.1: List of organisations / projects from which information was sought

3.8 Ecosystem-based indicator data was obtained for these organisations through secondary sources (website, state of the environment reports). Once compiled, summaries of the indicator sets being used were sent to each organization, together with a simple self-completing questionnaire (as at Annex I), for validation. As the regional organisations selected are predominantly using a modified DPSIR approach, an initial grouping was also made of the ecosystem-based indicators into PSR categories.

3.9 The indicators being used were then grouped by themes. Initially indicators were allocated to the following principal areas:

a. Living and non-living resources
b. Coastal resource availability

c. Water quality and contaminants
d. Physical parameters
e. Drivers, pressures and stresses
f. Socio-economic parameters
g. Management responses

Further allocation of indicators being used by selected entities was also made into one of 67 sub-topic themes (see Table 3.2).

3.10 This audit of indicators and indices was then analysed drawing upon individual organisations' responses to the questionnaires to determine commonality and critically evaluated to highlight good practice.

Fishing effort	Fishing
Climate - general	Compliance
Climate change	Certification
Sea level rise	Human activities other than fishing
Biodiversity	Ecosystem Goods & Services
Distribution/phenology/abundance/interactions	Ecosystems - general
Species composition / number /richness	Coast
CO2	Coral
SST	Mangroves
Sea Ice	Wetlands
Other Physical	Seagrass
Primary Productivity	Halophytes
Threatened species & habitats	Algae / Macroalgae
Habitats - general	Freshwater vegetation
Protection	Birds
Bathing water quality	Turtles
Eutrophication	Fish
Sediment	Reef Fish
Erosion	Marine mammals
Nitrogen / Phosphorus / Nutrients	Invertebrates
HAB	Soft-–bottom communities
Pesticides	Non-–coral reef hard substrate
Oxygen / Hypoxia / HS	Shipping
Chl / Chl a	Indices
Bacteria / Coliform	Monitoring & Evaluation
Water quality / Waster water –- general	Tourism
Pollution - general	EEZ
Marine Litter	Social
Hazardous Substances	Community
Oil / Petroleum	Human health
NIS / IAS	Economic
Jellyfish	Management
Zooplankton	Forests
Trophic Status	

Table 3.2: Sub-topic themes used to allocate ecosystem-based indicators in this study

3.11 A draft version of the report was considered by the 15th Global Meeting of Regional Seas held in Montego Bay Jamaica 30 September - 1 October 2013. Feedback from participants has been incorporated into the conclusions and recommendations in Chapter 7.

Structure of this report

3.12 This remainder of this report sets out the information researched as follows:

a) Chapter 4 - analyses the indicator systems in use or being developed in order to determine levels of commonality and pragmatic considerations such as the use of publically available global datasets;
b) Chapter 5 - presents the marine and coastal ecosystem-based indicator datasets collated from the 27 organisations/entities sampled and individual case studies illustrating specific aspects of how regional indicators and indices have been developed and are being used;
c) Chapter 6 - sets out a critical evaluation and proposal / justification for what is most suitable for the collective RSP taking into account scientific rigour, future needs, practicality and costeffectiveness; and
d) Chapter 7 - draws conclusions and recommendations.

4. Assessment of regional indicator systems developed to date

4.1 This chapter provides discussion of the research results drawing particularly upon the questionnaire responses. A distinction is made between State of the Environment reporting and indicators for specific targets and/or objectives. An assessment of why indicator data is collected, how often information is collated and whether the indicator systems that have evolved are fit for purpose is presented. Finally, opinion on constraints applying to indicator selection, application and communication are considered.

State of the Environment Reporting

4.2 A number of entities within the Regional Seas Partnership have now produced a succession of periodic State of the Environment reports as a means of summarizing complex information for policy makers. These summary documents convey information on multiple pressures acting simultaneously, often drawing upon and aggregating individual assessments and accounting for cumulative impacts (e.g. UNEP-MAP, 2012). Complementary topic specific reports are also published by some RSCAPs (e.g. HELCOM Pollution load reports; SPREP State of Pacific Coral reef Reports).

4.3 For other RSCAPs where such a reporting mechanism is not in place, plans to develop State of the Marine Environment reports are underway or envisaged. For example, some countries within the Abidjan Convention have a Pilot Project to develop a reporting template that seeks to adapt the UN Global Ocean Assessment (Regular Process) to the West African context (see draft template as at Annex II). Furthermore in some instances, where no regular comprehensive state of the environment report has yet been produced, interim reports on specific aspects have been produced. For example, the CEP has produced two comprehensive reports to date on pollution loading to the marine environment of the Wider Caribbean.

4.4 Similarly during the first phase of LME Programmes a main objective is to develop Transboundary Diagnostic Analyses (TDAs) as well as establishing Demonstration Pilot Projects and Regional Institutional Mechanisms. Information on current status of marine resources and the environment (both biophysical and socio-economic aspects) is gathered to establish a baseline that informs the condition/quality assessment presented in the LME's regional Strategic Action Programme (SAP). Again this is often based on benchmark studies (e.g. BOBLME study on Performance in managing hilsa and Indian mackerel in the Bay of Bengal). Following this 'initial assessment' in some cases subsequent evaluations are undertaken. For example, the Arafura-Timor Seas plan to undertake a mid-term evaluation/update (after 5 years) of implementation progress and a final evaluation (after 10 years) of changes to process, pressure and state in the ATSEA region resulting from the implementation of their SAP.

4.5 However, both the quality and frequency of these reports varies. Efforts to achieve greater consistency of national reporting as a basic input to consolidated assessments and reports have generally concentrated on development and refining reporting formats.

4.6 The frequency of State of the Environment reporting is a political decision (see the example of OSPAR below). Some RSCAPs set a regular period (e.g. Black Sea every 5 years) but others are more flexible. For example, ROPME has produced State of the Marine Environment Reports in 1999, 2000, 2003 and a fourth is scheduled for 2013. As a consequence political agreement can trigger the start of State of the Environment reporting. For example, entry into force of the CEP Land Based

Sources of Marine Pollution Protocol has led to approval of an outline for a first State of Convention Area Report.

Box 1: OSPAR State of the Environment reporting schedule

The Convention for the Protection of the Environment of the North-East Atlantic (OSPAR Convention) requires, in its Article 6 and Annex IV that "*the Contracting Parties shall, in accordance with the provisions of the Convention, in particular as provided for in Annex IV:(a) undertake and publish at regular intervals joint assessments of the quality status of the marine environment and of its development, for the maritime area or for regions or sub-regions thereof; (b) include in such assessments both an evaluation of the effectiveness of the measures taken and planned for the protection of the marine environment and the identification of priorities for action*.". The 2000 Quality Status Report was published as a set of 6 reports[8], the most recent 2010 Quality Status Report (OSPAR, 2010) was a single report with more attention to web-based access of both the main report and the underlying contributing assessments[9].The planned 2017 Intermediate Assessment will be articulated around Contracting Parties agreed 'common indicators' (and to the extent possible 'priority candidate indicators') in the run-up to their[10] 2018 updating of the Marine Strategy Framework Directive Art. 8 assessment. The next comprehensive OSPAR Quality Status Report is provisionally planned for 2021.

4.7 Some entities, such as CCAMLR, whilst not producing a State of the Environment report, instead periodically assess the status and trends of marine resources. For CCAMLR this applies to components of the Southern Ocean marine ecosystem with a focus on living resources that are the target of harvesting activities together with associated and dependent species.

4.8 All entities are aware of the UN Global Ocean Assessment (Regular Process) and have variously contributed to a round of Regional Workshops. For example, within this process CPPS have compiled and digitized 158 assessment documents for their region (CPPS, 2013).

Indicator systems linked to State of the Environment reporting

4.9 Predominantly, State of the Environment reporting is underpinned by 'state' indicators. Jennings (2008) considered these state indicators most suited to long-term policy-focused feedback on the effects of management action with pressure and response indicators rather guiding short-term management decisions. State indicators generally describe an ecosystem-based component or process and that parameter's quality relative to the baseline and/or previous assessments.

4.10 A number of entities have well-established indicator systems (see HELCOM case study in Chapter 5). For others the development of an indicator system is a dynamic process. For example, traditionally OSPAR has not articulated its monitoring and assessment activities around the 'indicator'

[8] http://www.ospar.org/content/content.asp?menu=00650830000000_000000_000000

[9] http://qsr2010.ospar.org/en/index.html

[10] 10 OSPAR Contracting Parties are EU Member States bound by the MSFD.

notion (but rather on a basis in which parameter monitoring data and other information would be combined into more integrated assessments). However, this is now changing. The OSPAR Commission and its Secretariat have been preparing over the last two years the existing regularly reported data streams for more extensive use, including in the context of OSPAR Assessment Sheets and indicators, i.e. 'smaller units of assessment'. The OSPAR Commission meeting of 24-28 June 2013 agreed a first set of common indicators and of candidate indicators which will become a more important component of the Joint Assessment and Monitoring Programme (JAMP), which is OSPAR's umbrella programme for such activities. The next JAMP is due to be adopted by OSPAR 2014 and should cover the period from 2014 until the next QSR (2021).

4.11 And for several entities development of an indicator system is work in progress. For example, NOWPAP has devised draft indicators as part of Ecological Quality Objectives to be presented to the 18th NOWPAP Intergovernmental Meeting in December 2013. Use of indicator systems is generally also becoming more sophisticated, moving from descriptive qualitative approaches to more quantitative assessments (e.g. PERSGA).

4.12 Humbolt Current LME (HCLME) are using the Ocean Health Index and are encouraging the governments of Chile and Peru to look closely at the indicators where they currently have a zero score. In addition they use the Management Effectiveness Tracking Tools for IW and BD as designed by GEF. There is also an Insignia Species list with species selected to reflect the state of the HCLME health in terms of population dynamics. Further indicators are to be selected as a consequence of the Causal Chain Analysis work.

Selection of State of the Environment reporting indicators

4.13 Considerable technical discussion by region-specific assessment and monitoring working groups has been undertaken to date and continues to underpin proposals for indicator systems.

4.14 For some entities this can be project-based. For example, CPPS SPINCAM project identified a series of national indicators, and five regional indicators (coastal population dynamics, marine water quality, marine protected areas coverage, biodiversity, and advances in Integrated Coastal Zone Management using different approaches). These indicators were selected through workshops in participative processes with most relevant stakeholders of CPPS member states in the region (Chile, Colombia, Ecuador, Panama and Chile).

4.15 For PEMSEA the process of developing the set of indicators for their State of the Coasts reporting entailed a series of consultations with experts on environmental assessments, and the compilation, analysis and preparation of a matrix of indicators from various environmental assessments and management programs conducted within and outside the East Asia Seas (EAS) region. From the matrix, a total of 160 indicators were selected based on the following criteria: a) simple and meaningful; b) easy applicability in the EAS region; and c) complementary to the indicators identified in relevant international instruments. The selected indicators for the SOC were organized in accordance with the Sustainable Development of Coastal Area Framework. From the 160 indicators, 35 core indicators were determined as the essential information needed to evaluate the progress in ICM implementation based on PEMSEA's experience in developing and implementing ICM programs at the local government level. Details on the indicators can be accessed through http://www.pemsea.org/publications/guidebook-state-coasts-reporting.

4.16 For the RSP, indicator selection has been generally regionally specific, with each entity giving due consideration to methodologies (e.g. PERSGA Standard Survey Methods for key habitats and species groups). European entities have sought commonality on the basis of selection criteria linked to monitoring parameters with the potential for use in the context of EU MSFD 'good environmental

status' (either its determination or as a tool to evaluate progress towards a target) and an important factor has been the degree of (sub) regional transboundary interest. Selection is also influenced by the availability of monitoring data tempered by economic reality as well as scientific justification. HELCOM, for example, stated that most of the indicators they have selected are based on traditional monitoring activities, not targeted to note small-scale pollution sources or pressures. HELCOM are also engaged in a process to evaluate how well remote sensors or automatic buoys could be used to replace ship-based monitoring.

4.17 Many LMEs have had a tendency to adopt TWAP indicators, thus their selection process is more prescribed and generic. In addition CLME state that work to be initiated in the second half of 2013 (to include process, stress reduction, environmental and socio-economic status indicators) will make reference to Causal Chain Analysis of environmental degradation and development under their TDAs.

Specific management targets and/or objectives

4.18 The effectiveness of any Strategic (or Regional) Action Plan, to improve and/or maintain the state of the environment, is generally measured in terms of rate of progress against specific targets or quantitative thresholds. Diagnostic reports also feed into any revisions of the SAPs.

4.19 Such targets stem from the adoption of Protocols and/or Annexes to Regional Conventions and dictate and/or inform Programmes of Work. For example, the Bucharest Convention has five associated Protocols and has adopted two Strategic Action Plans (one in 1996 based on policy actions and the second in 2009 based on Ecosystem Quality Objectives and respective management targets). HELCOM has established a vision, four strategic goals and ecological objectives: assessment of the implementation of Baltic Sea Strategic Action Plan 2009 (which will be completed provisionally in 2015) relies on three sets of monitoring and evaluation indicators. The Nairobi Convention takes due account of the West Indian Ocean SAP alongside its Protocols which together provide the mandate for developing indicators. OSPAR adopted a North-East Atlantic Environment Strategy at ministerial level and a set of Ecological Quality Objectives, originally adopted under the Ministerial North Sea Conferences, is still being mainstreamed into the overall OSPAR monitoring and assessment approach.

4.20 Targets therefore are largely driven by the national and regional requirements of Contracting Parties. For example, UNEP-MAP set an outlook for sustainable development while the achievements are tracked using agreed indicators (Plan Bleu, 2012). Such targets should also be informed by and compatible with marine-related intergovernmental targets such as the marine-related Aichi Targets and ecosystem-related fisheries targets and pan-regional obligations such as the EU MSFD. The level of commitment (aspirational / legally binding) varies across different contexts. For example, the 'good environmental status' objective of the EU MSFD is a driver for development of assessment methods and criteria, as this is a legally binding objective (subject to MSFD-internal qualifications).

4.21 The Sustainable Development Strategy for the Seas of East Asia (SDS-SEA, 2003), which was adopted by 12 countries in the EAS region in 2003, consists of 6 strategies and 227 action programs that Countries commit to implement for the sustainable development of coastal and marine areas. It also serves as a platform for Countries to achieve the goals of key international agreements and action plans. In line with SDS-SEA implementation, key sustainable targets were identified in the Haikou Partnership Agreement (2006), Manila Declaration (2009) and the Changwon Declaration (2012), which were adopted by the countries in the EAS region. At the local government level, targets for the sustainable development of coastal and marine areas are embodied in their Coastal Strategy,

Coastal Strategy Implementation, Strategic Environmental Management Plans, and Local Development Plans.

4.22 CPPS stated that there are several programs associated to the Southeast Pacific Action Plan generating information and assessments that eventually would allow defining a set of monitoring and management indicators of global scope. Within their region a regular monthly newsletter has been published for more than 20 years for monitoring of climate conditions in the South Pacific related to El Niño.[11]

Box 2: Arafura and Timor Action Plan (ATSEA) Objectives and Targets

Objective 1.1. : To promote responsible fishing practices, including combating IUU fishing

Target 1.1: IUU fishing reduced in the Arafura and Timor Seas (ATS) by 15-20 %

Objective 1.2: Understand and address the ecological impacts of fisheries

Target 1.2: Ecosystem Approach to Fisheries Management applied across the ATS

Objective 2.1: To strengthen the management of biodiversity, especially ecologically important habitats, including mangroves, coral reefs and seagrass beds

Target 2.1: Enhanced management and protection of 20 % of marine and coastal habitats (including mangroves, coral reefs, and seagrass beds)

Objective 3.1: To prevent and reduce inputs of pollutants from coastal point land sources (wastewater, sewage and industrial) and diffuse sources (land-use)

Target 3.1: Reduction of the ecologically harmful impacts of nutrients in coastal waters from base year

Objective 4.1: To reverse the decline in threatened and migratory marine species (such as turtles, dugongs, seabirds/shorebirds, sea snakes, sharks and rays) in the ATS region

Target 4.1: Enhanced protection of 10-20% of important habitats for threatened and migratory marine species; 20% decrease in direct and indirect harvesting of threatened and migratory species

Objective 5.1: To promote the adaptive capacity and resilience of coastal and marine ecosystems and reduce vulnerability of local communities to climate change

Target 5.1 Increased understanding of climate change impacts and incorporation of that knowledge into management plans and strategies, including establishment of management plans for more than 60% of at-risk coastal villages

[11] Bulletins are available on:

http://cpps-int.org/images/BAC/bac_eng/BAC%20Issue251-%20ABSTRACT%20VERSION.pdf

4.23 Thus target setting for the RSP contains a strong political dimension. This is also true for LMEs as their SAPs must be endorsed by Ministers, a Regional Mechanism then becomes the overall body responsible for monitoring and evaluation of the SAP with annual reporting of implementation progress and key indicators and 3-yearly reporting on the SAP Implementation Plan. For example, ATSEA have 5 Ecosystem Quality Objectives and 7 Operational Objectives each with quantitative targets to be achieved within a fixed time period (linked to other agreed actions e.g. IUU Fishing regional Plan of Action) (see Box 2).

4.24 Many LMEs are still establishing performance indicators e.g. BOBLME draft indicators currently under review in the draft SAP.

Periodic collection of information

4.25 For regional entities with more established indicator systems most data streams have an annual reporting requirement with specific reporting formats. For example, CCAMLR requires annual submission of data, which is then reviewed and presented to their Scientific Committee. The HELCOM Monitoring and Assessment Strategy (HELCOM, 2013) includes a six-year assessment cycle. Therefore each core indicator must be assessed at least once in six years to give input to integrated assessments. Depending on core indicators, the frequency of updating varies from 1 to 6 years, but most core indicators are updated annually. Baltic Environment Fact Sheets are updated mainly annually. OSPAR has a Coordinated Environmental Monitoring Programme, which prescribes agreed reporting procedures for Contracting Parties to submit data annually to qualified data centres. CPPS has a programme of annual cruises that have now been ongoing for 14 years.

4.26 LMEs stipulate what must be collected and analysed as part of their SAP implementation. This means that data is not necessarily collected periodically. BOBLME and ATSEA confirmed that data and information were collected for the purpose of developing TDA and SAP (and NAPs). Subsequent collection can be region specific and not necessarily driven by any annual cycle. For example, ASC stated that many ocean-atmosphere data are collected on a near real time basis.

Iterative development

4.27 Considerations of whether indicator systems are 'fit for purpose' sought to understand whether systems in place are working or not. This was clearly not relevant for those entities whose indicator systems are still under initial development and/or yet to be implemented (e.g. Abidjan Convention, ATSEA, ASC, SPREP). For those not currently at the point of regular, targeted reporting - the aim of current efforts is to streamline indicators and build capacity in State of the Environment reporting.

4.28 Some entities considered any judgement of the effectiveness of indicator systems to be an on-going process. For example, technically, and in so far that OSPAR monitoring and assessment in the past was not indicator-based, OSPAR indicators are not yet 'working'. The (expected or actual) performance of indicators will be part of the discussion during development and will also be examined alongside their application. As any activity, monitoring and assessment activities also lead to 'learning by doing' and hence changes can be made as necessary. The decision basis of the indicators is quite flexible (a so-called 'agreement' in OSPAR, not a formal Recommendation or Decision) so that the set of indicator or the technical description of indicators can be amended at the Committee or OSPAR Commission level. For the Black Sea Commission testing is progressive: once the relevance of indicators selected so far is proved, work will continue for development of other indicators. Likewise PEMSEA consider their indicator development as an iterative, evolving process that will be enhanced

to capture indicators covering emerging issues, key developments in various international instruments and site-specific requirements. Several LMEs stated that the effectiveness of their indicators will be tested as part of the TWAP 2nd level assessment.

4.29 For HELCOM, in principle each core indicator has been tested against real data and time series. HELCOM states that the main difficulty is to judge whether the dynamics is caused by anthropogenic pressures or natural variation and where to place the threshold for good environmental status (GES). The expert groups responsible for the core indicators are tasked to evaluate the performance of the core indicators and the GES thresholds and adjust them if necessary. For some other entities, such as PERSGA, problems with lack of time series and limited spatial coverage made indicator systems less effective (Cf. section below on Constraints on indicator selection and application). For entities whose indicators are linked to compliance (e.g. CCAMLR, CPPS) agreed standards are also regularly reviewed by an expert group.

Constraints on indicator selection and application

4.30 For all regional entities the development of indicator systems is a technical and financial burden. These related factors have impacted on indicator system choice and effectiveness. For example, SAS stated that the agreement on indicators tailor-made to the conditions of South Asia as well as monitoring them depends on financial and technical support as well as political commitment from member governments. Technical capacity to undertake periodic monitoring and survey activities was frequently cited as a limiting factor, not only by regional entities currently developing indictor systems but also by those with established processes (e.g. PERSGA). In some cases this is exacerbated by limited access to data, particularly from State organisations (e.g. HCLME; ROPME). Regions with diverse governance arrangements face particular challenges in this respect (e.g. SPREP).

4.31 Similarly the cost of marine monitoring programmes is a significant current concern in many regions and this has been an important factor in the decision making process so far. Some indicators may require (a combination of) (1) expensive sampling or observation platforms and equipment; (2) highly specialised analytical or observation equipment; (3) highly qualified personnel. Another limiting factor is that the scale at which any of these can apply limit the application of 'economies of scale' and progressive cost-reduction with upscaling of operation. This is an area of great current concern not only for regions dominated by developing States but also, for example, in several European starting and on-going projects with which OSPAR, HELCOM and UNEP-MAP have links.

4.32 Efforts to work around these principle barriers include the application of technological solutions and capturing regional dimensions of global datasets. An example of the former is the Black Sea Commission who face financial constraints limiting their monitoring capacity (e.g. eutrophication indicators). Enhanced use of satellite observations and automated systems for monitoring respective parameters is therefore being explored. Special algorithms for use of satellite images to calculate Chlorophyll concentration for coastal and open-ocean waters are under development.

4.33 In terms of the latter, in the BOBLME, due to limited funds available in view of the vastness of the area (6.2 million km2), the productivity and fish and fisheries indicators (LME modules) will not be covered; this is mitigated by a) joining the IOGOOS (UNESCO-IOC) and b) establishing the ecosystem characteristics and developing an ecosystem model (CSIRO and UBC-SAUP). The Global Ocean Observing System (GOOS) is a scientifically designed permanent, international system for gathering, processing, and analyzing oceanographic observations on a consistent basis, and distributing data products. It gathers data by remote sensing, sea surface, and sub-surface instrumentation, from the open-ocean, coastal and shelf seas. GOOS products describe the state of

the ocean globally at regular intervals. Data and data products are available to all States (GOOS, 1993).

4.34 Within this research study twelve entities reported the use of global datasets (Table 4.1).

Entity	Data sets	Purpose
BSC	http://oceancolor.gsfc.nasa.gov/	Environmental indicators (for state, pressure, impact) are calculated and used in the assessment
	http://www.enviport.org/meris/lv3_main.htm	
	http://www.myocean.eu/	
	http://www.emodnet-hydrography.eu/	
	http://www.emodnet-chemistry.eu/portal/portal/	
	http://bio.emodnet.eu/portal/index.php	
PERSGA	UNEP and others	Status of marine biomes (coral reefs, mangroves etc.)
	NOAA, and several other data types available from IOC, GOOS, GLOSS	Climate
ROPME	ESRI	For world base map
	UNEP World Conservation Monitoring Centre	For monitoring parameters
	World Database on Protected Areas (WDPA)	Area and location of PA sites within the ROPME Sea Area
	IOC-UNESCO	Reference for Taxonomic List of Harmful Micro Algae
	Global Ocean Observing System (GOOS)	Data parameter reference and sourcing of marine indicators
	Ocean Data Standards Pilot Project (ODS)	Data parameter reference
Nairobi Convention	UNEP Global Environment Outlook (GEO) Data Portal	Used for integrated environmental assessments and is accessible on http://geodata.grid.unep.ch/;
	The IUCN Red List	To track status of endangered or threatened flag ship species in the WIO coastal and marine environment
	UNEP Global Resource and Information Database (GRID)	Environmental alerts and atlases
	UNEP World Conservation Monitoring Centre (WCMC)	information on biodiversity and ecosystems
SACEP-SAS	Indicators developed by CBD, Biodiversity	

	Indicator partnership, Protected planet, World Bank , FAO	
CEP	Data from the World Database of Protected Area Also OBIS, WOD/NOAA	Were used for some MPA datasets of the Caribbean Regional MPA Database
OSPAR		For issues of global interest e.g. MPAs, ocean acidification), on-going developments of data management take account of the global context. Where global datasets are available that can aid in OSPAR monitoring and assessment activities, the experts involved in the OSPAR work will endeavour to take this into account
BOBLME	SAUP	Fish and Fisheries MPA Satellite data (oceanography, hydrography)
	WDPA-WCMC	
	NOAA	
CLME		Global datasets are being used by CLME stakeholders. However the amount of CLME stakeholders is vast, and their data needs are substantial and diverse. Usefulness of global datasets is high, but detailed reporting on its full usefulness and applicability falls outside the scope of a questionnaire like this. We do see great utility however in undertaking such detailed analysis in due time.
ASCLME	Many global data sets	See: www.africanmarineatlas.org
CPPS	GOBI and CBD	Maps for the Atlas
HCLME	http://www.oceanhealthindex.org/	Please see areas for Chile and Peru

Table 4.1: Entities using global datasets

Collation and communication of indicator information

4.35 For most regional entities, publications and assessments based on indicator information are uploaded on respective websites. However, databases and information portals are at various stages of development and not all allow open access. For example, CPPS has an ATLAS of metadata for different databases including biodiversity (distribution of whales, sharks, marine turtles), oceanographic data from regional cruises, pollution, and MPAs. ROPME is developing an online web application called the ROPME Integrated Information System (RIIS) located at www.riis-ropme.org, which will be formally launched in November 2013. RIIS databases are a compilation of ROPME's data on oceanographic cruises, contaminant surveys, satellite images and specific resources from Members States on their human resources, scientific studies and periodically updated environmental indicators. The RIIS is a map-based application with default general public domain access but special privileges are accorded to Member States to have more access and rights to update and modify data.

4.36 The Black Sea Information System (BSIS) includes a database, developed recently within a project funded by EC-DG Environment (Baltic2Black). The database is dedicated to the collection of data for pollution; it is hosted by its developer, Ukrainian Scientific Centre for Ecology of the Se (UkrSCES) that functions as the Regional Activity Centre for Pollution Monitoring and Assessment (PMA RAC) and is available online at http://rdbp.sea.gov.ua/. Other databases have limited online accessibility for the time being. More efforts (financial, human resources) are considered necessary to maintain the already created system and databases functional.

4.37 CCAMLR has a database of CEMP sites, parameters and indices and although this is not available to the public, extracts can be released on request. For regional entities in Africa the African Marine Atlas acts as a repository for spatial data, and the Nairobi Convention Clearing house Mechanism for metadata. www.africanmarineatlas.org, http://gridnairobi.unep.org/CHMPortal/ptk

4.38 Several entities have databases under development and/or they are consolidating data and realigning information systems. Often this is in partnership with collaborative national scientific and research institutes as well as NGOs and specific donor assisted capacity building projects (see Box 3). For example the Abidjan Convention is working with GRID-Arendal, and in the same region the Spanish Oceanographic Institute developing a geo-referenced database on water quality, habitat and biodiversity of CCLME countries. For CLME a pilot project called "Prototype Information Management System/Regional Environmental Monitoring Programme" (see also www.clmeproject.org was executed by IOC of UNESCO. Preliminary results from this pilot project are currently available, but the final reporting (including on a proposed indicators set) has not yet been delivered. A prototype "Atlas and Information Booklet on the Status of the Marine Environment" is also envisaged.

Box 3: Diverse Partners working with CEP

Regional Activity Centres for the LBS, Oil Spills and SPAW Protocols - located in Cuba, (CIMAB), Trinidad and Tobago (Institute of Marine Affairs), Guadeloupe (SPAW RAC) and Curacao (Oil Spills RAC - REMPEITC). Other key partners included the Caribbean Environmental Health Institute based in St. Lucia, INVEMAR based in Colombia, NOAA and the USEPA, CATHALAC (Panama), NGOs such as CANARI, The Nature Conservancy, Gulf and Caribbean Fisheries Institute, WRI, WWF, CI, Birdlife, WIDECAST and national and technical focal points of Governments in the Wider Caribbean Region.

Summary

4.39 For State of the Environment reporting ecosystem-based indicator systems have developed in an *ad hoc* way influenced by regional pressures and priorities. Indicator systems linked to targets and objectives have been more coordinated (TWAP and LMEs) and the EEA is an example of pan-regional coordination associated with regulatory requirements. Indicator information is most usually collected on an annual basis but this is not always the case with the possibility of some near real time data collection. Most indicator systems in place are being adapted and refined based upon evaluations of their usefulness and practicality. However, all regional entities regard them as costly and technically challenging. There is something of a mismatch between expectations of policy and ability to achieve reporting needs and an opportunity to consider which global data and information streams can best serve to support the needs of the RSP.

5. Use of indicators to monitor progress in achieving targets and/or objectives

5.1 The aim of this chapter is to review existing indicators, currently being used by the entities identified. Of the 27 entities selected for the study (Table 1, Chapter 3), 18 provided responses to the questionnaire. Of these, 9 were selected as case studies to illustrate different approaches and applications. As explained in Chapter 1, indicators and indices by their nature aggregate and simplify complex information. Explaining the choice of indicator suites can therefore easily miss important detail and underpinning scientific rationale for their adoption. To avoid this, a compilation of all reported indicators as part of this research, and scientific rationales can be found by referring back to specific publications of individual entities as highlighted in individual case studies.

5.2 Analysis revealed that over 1,250 indicators are either being used or are under consideration by the entities that provided information. For each of the topics, the approximate number of indicators is given in Table 5.1. Some indicators have been assigned to more than one topic. In particular for the categories 'Water Quality and Contaminants', 'Socioeconomic Parameters' and 'Management and Response' indicators could be applicable to more than one category, for example BSC's 'lists of emissions developed' or ROPME's 'percentage of annual budget allocated for biodiversity issues'. Where this is the case the indicators have been assigned to both applicable categories. Notwithstanding these complexities with allocation to category, living and non-living resource indicators are the most used category.

Category	No. of indicators
Living & Non-living Resources	451
Water Quality and Contaminants	270
Coastal Resource Availability	45
Physical Parameters	62
Drivers, Pressures and Stresses	118
Socio-economic parameters	197
Management and Response	228

Table 5.1. Number of indicators assigned to each category

Specificity

5.3 There was wide disparity between indicators. Some comprised an individual parameter such as 'number of strandings', 'bycatch', 'sea surface temperature', 'fishing gear': while other indicators comprised a combination of parameters, for example OSPAR's 'changes in proportion of large fish' or EEA's 'nutrients in transitional, coastal and marine waters'.

5.4 In some cases only very specific types of indicators are used when the entity is focused on one particular aspect of the environment such as biodiversity, e.g. CCAMLAR (Case Study 1).

Case Study 1[12]: Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR)

As part regional sea convention / part regional fisheries management organization, CCAMLR is responsible for the conservation and management of marine living resources in the Convention Area (the Southern Ocean).

The Convention's management objectives aim to balance "conservation" and "rational use" of marine living resources to ensure that stocks are harvested sustainably, existing ecological relationships between harvested, dependent and related species are maintained and depleted populations are restored to levels at which their biological productivity is greatest (FAO, 2013).

Dependent species monitoring

It was realised at the establishment of CCAMLR that in order to regulate harvesting of Antarctic living marine resources in accordance with the 'ecosystem approach' embodied in Article II of the Convention, the effect of such harvesting on dependent species (predators) would have to be monitored.

CCAMLR started planning its CCAMLR Ecosystem Monitoring Program (CEMP) in 1984, with the following aims:

- to detect and record significant changes in critical components of the ecosystem, to serve as a basis for the conservation of Antarctic marine living resources; and
- to distinguish between changes due to harvesting of commercial species and changes due to environmental variability, both physical and biological.

While CEMP's largest component is the monitoring of dependent species, in order to distinguish between changes due to harvesting and those due to environmental variability, the program also monitors harvested species, harvesting strategies and environmental parameters such as wind, temperature and the amount of snow and / or ice cover.

CEMP does not attempt to monitor all dependent species (sometimes termed 'indicator species') within the Antarctic ecosystem, but concentrates on a few which are likely to respond to changes in the availability of harvested species - currently krill and fish. The indicator species must be specialist predators on the prey items identified, have a wide geographical distribution and be important ecosystem components. The selection of indicator species is also based on their potential to respond to changes in prey availability or environmental factors and their amenability to regular monitoring. The current list contains the crabeater and Antarctic fur seals, Adélie, chinstrap, gentoo and macaroni penguins, Antarctic and Cape petrels and black-browed albatross.

The CEMP uses indices derived from data on indicator species and the environment collected by standard methods[13] within three Integrated Study Regions of the Convention Area. These indices monitor: reproduction; growth and condition; feeding ecology and behaviour; abundance and

[12] Source: CCAMLR, 2004. Standard Methods. CCAMLR Ecosystem Monitoring Programme, CM 22-06 and CM 22-07)

[13] CCAMLR Standard Methods: http://www.ccamlr.org/en/system/files/std-meth04.pdf

distribution. Data derived from these indices allow for the ascertaining of trends and anomalies in populations. The scales over which these parameters are expected to integrate changes in the status of the ecosystem varies from days-weeks in the vicinity of monitoring sites (e.g. breeding success, offspring growth rates) or region wide (e.g. weight of birds arriving to breed, adult survival).

Two sets of sites were chosen for the monitoring program: a core set of sites within three defined Integrated Study Regions (ISR) (regions for the intensive study of predators, prey and environmental interactions), and a network of additional sites which complement the research within these regions Within the ISRs, sites may be adjacent to harvesting areas or isolated from them, allowing a controlled experimental design.

Fieldwork and data acquisition for the program are carried out voluntarily by CCAMLR Member States. The data collected are submitted to the CCAMLR Secretariat, which carries out specified standard analyses for consideration by WG-EMM. The Secretariat also collects and archives data used by the program which are acquired from other national and international environmental monitoring programs, for example, satellite-derived sea-ice and sea-surface temperature data.

Vulnerable Marine Ecosystem (VME) indicators

As a Regional Fishing Body (RFB), CCAMLR carries the responsibility for assessing the potential impact of fishing activities on vulnerable marine ecosystems within the Convention Area (CCAMLR, 2007; UNGA, 2007; FAO, 2009). The collection and reporting of VME-indicator data in accordance with CCAMLR Conservation Measures 22-06[14] and 22-07[15] is a Flag State responsibility. The measures require vessels to monitor by-catch for the presence of vulnerable marine ecosystem (VME) taxa defined by the Commission and listed in the CCAMLR VME Taxa Classification Guide 2009 (CCAMLR, 2009).

The guide provides observers, fishers, and biologists while at sea with a taxon-specific, quick, ondeck guide to aid in the classification of macroscopic marine invertebrate by-catch into the required VME groupings. The VME taxa are a subset of the total invertebrate taxa encountered as fishery bycatch. Consequently, further processes are required to collect information on non-VME taxonomic groups. Invertebrate identification is not generally done at sea because it requires specialised tools. The VME guide format is a 'compare and contrast table', using photographs and key characteristics to aid the correct assignment of VME taxa to the appropriate grouping. The guide also highlights commonly confused groups (CCAMLR, 2009, p.4).

The Measures clearly define the guidelines for the collecting and reporting of data (Measure 22-07).Vessels are required to report the collected data to the CCAMLR Secretariat, either directly when authorised to do so (with copy to the Flag State), or via the Flag State.

A 'VME indicator unit' is defined as either one litre of those VME indicator organisms that can be placed in a 10-litre container, or one kilogram of those VME indicator organisms that do not fit into a 10-litre container.

A 'line segment' is defined as a 1,000-hook section of line or a 1,200 m section of line, whichever is

[14] CM 22-06 (2012): Bottom fishing in the Convention Area http://www.ccamlr.org/sites/drupal.ccamlr.org/files//22-06_3.pdf

[15] CM 22-07 (2010): Interim measure for bottom fishing activities subject to Conservation Measure 22-06 encountering potential vulnerable marine ecosystems in the Convention Area http://www.ccamlr.org/sites/drupal.ccamlr.org/files//22-07.pdf

the shorter, and for pot lines a 1 200 m section.

'Risk Area' is defined as an area where 10 or more VME indicator units are recovered within a single line segment. A Risk Area has a radius of 1 nautical mile from the midpoint of the line segment from which the VME indicator units are recovered. However, Members may require their vessels to observe a larger Risk Area in accordance with their domestic laws.

Vessels are required to clearly mark the start and end of each line segment on each longline or pot line, and to monitor all line segments for the quantity of VME-indicator organisms recovered during hauling.

If 10 or more VME indicator units are recovered in one line segment, the vessel must complete hauling any lines intersecting with the Risk Area without delay and not to set any further lines intersecting with the Risk Area. The location of the midpoint of the line segment from which the VME indicator units were recovered together with the number of VME indicator units must be immediately communicated to the Secretariat and to the Flag State.

If five or more VME indicator units are recovered within one line segment vessels must immediately communicate to the Secretariat and their Flag State the location of the midpoint of the line segment from which those VME indicator units were recovered along with the number of VME indicator units recovered.

CCAMLR's use of indicator species for both the dependent species and VME monitoring illustrates a highly focussed use of indicators for very specific monitoring requirements. As a 'hybrid' regional entity (part regional sea convention / part regional fisheries management organisation) the CCAMLR system is required to integrate biodiversity protection with resource management, a system more in line with the ecosystem approach than many other entities.

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Numbers of indictors being used

5.5 The number of indicators being used by entities ranged from 5 for CPPS, derived from the SPINCAM Project[16] with a broad, generic coverage e.g. biodiversity, marine water quality, to 15 and 16 respectively for the Caribbean Environment Programme and Nairobi Convention, to many: in the case of the PERSGA, 158 (Case Study 2), very detailed, species-specific indicators.

Case Study 2: Regional Organization for the Conservation of the Environment of the Red Sea and Gulf of Aden (PERSGA)

PERSGA is the intergovernmental body dedicated to the conservation of the coastal and marine environments found in the Red Sea, Gulf of Aqaba, Gulf of Suez, Suez Canal, and Gulf of Aden surrounding the Socotra Archipelago and nearby waters.

While site-specific data on resources, human uses and impacts are a key component of coastal planning and management such information is either limited or absent for some PERSGA member states. This type of information can be obtained more readily from broad scale, rapid environmental assessments than from focused disciplinary research (PERSGA, 2004). Rapid assessment methods (RAMs) are an appropriate approach for the effective survey of relatively large areas of marine and coastal environment to help with the development and design of site-specific management plans. In the PERSGA region a range of sampling methodologies are deployed ranging from the rapid assessment technique to more detailed quantitative survey methods.

PERSGA has developed Standard Survey Methods (SSMs) (PERSGA, 2004) for the region for key habitats. The SSMs were prepared by international experts, following a review of the methods currently in use around the world, and then contextualised for the region. PERSGA SSMs cover mangroves and intertidal biotopes, coral reefs, and sea-grass beds, marine turtles, sea birds, and marine mammals. A range of alternative methods is presented, designed to suit surveys of increasing complexity when more detailed information is required. A major advantage of using standard methods is that data collected using these methods will be comparable across the region and will allow environmental changes to be detected and monitored at a regional level. Standardised data collection and analysis will also provide the necessary information from which similar, consistent, regional legal and executive frameworks can be developed for habitat and biodiversity conservation (PERSGA, 2004).

These methods include a range of indicators specific for each habitat or species group (Table 1). They have been selected based on particular characteristics and features of the subject habitat or species group. As a consequence, they are mostly indicators of 'State'. However, PERSGA is planning to develop new indicators to address 'Pressure' and 'Response' as well as indicators addressing governance and socioeconomic aspects.

[16] http://www.spincamnet.net/

Table 1. Summary of survey method and indicators used in the Rapid Coastal and Environmental Assessment (PERSGA, 2004)

Survey Method		**Indicators** (Ecosystems, species groups, uses and impacts)
Based on inspection quadrats 500m x 500m extending 250 m up the shore and 250 m down into the subtidal zone)	Ranked abundance / magnitude (log scale) Areal extent (flora and reefs) (m^2) Number of individuals (other fauna)(arithmetic range)	**Ecosystems/Species** **Flora:** Seagrasses Algae Halophytes Mangroves Freshwater vegetation **Fauna:** Coral / reefs Birds Turtles* Mammals** Fish Invertebrates **Human uses / Pressures (Impacts)** Oil Human litter (plastics, metals, other solid waste) Driftwood and wood litter Construction/development Fishing
		*including turtle pits and swimming / feeding turtles **marine mammals / terrestrial mammals

While the rapid assessment allows a useful broad overview, the detailed survey methods allow a much finer resolution understanding of the state of the species. The more detailed survey methods for specific species for example, for seagrasses, include the root / shoot ratio, the leaf surface area in a particular quadrat and leaf production. For mangroves, the height and girth of trees is proposed while, for turtles, parameters include the characteristics of the nests, number and size of eggs, weight and length measurements of individual animals.

References

PERSGA, 2004. Standard Survey Methods for Key Habitats and Key Species in the Red Sea and Gulf of Aden. PERSGA Technical Series No. 10. Pp 310.

5.6 In some, but not all, cases this may reflect not only the level of focus (e.g. CCAMLR application of indicators to VMEs) but also the level of maturity of indicator systems being used. Thus, some entities only have indicators that are either proposed or under development (e.g. Caribbean Environment Programme) whilst others have been applying their systems over several years or decades. In the latter case the indicators have been and continue to be honed over time.

5.7 Some suites of indicators are very detailed (e.g. PERSGA, Case Study 2). While very detailed metrics tend to complicate the 'bigger' picture they are vitally important for 'region specific' analyses to add specific information. The most detailed suites of indicators relate primarily to particular aspects of biodiversity (living resources) but also to litter. For example, OSPAR lists 12 litter-types under the 'beach litter' category and a further 8 under the 'tourism and recreational activities' litter. Within all OSPAR categories of litter approximately 50 litter-types are listed.

Underlying rationale for indicator selection

5.8 Responses to the questionnaire show that there is a wide range underlying rationales for indicator selection. These include availability of data, scientific needs, local and regional government priorities, SAP requirements, environmental monitoring and monitoring implementation action plans.

5.9 The very large number of indicators and the level and range of detail within the sets (presence/absence versus properties) made it difficult to gain a clear picture of the common themes being addressed. Grouping under the 6 original broad topic headings (Living/Non-living Resources; Water Quality and Contaminants; Coastal Resource Availability, Drivers, Pressures and Stresses; Socioeconomic Parameters and Management and Response) failed to clarify common themes. However, while working through the indicators an initial suite of 67 sub-topics became apparent - although further work is needed to refine this, particularly for general headings of fisheries, pollution and management, is necessary (Table 2, Chapter 3).

5.10 While some entities' indicators address a very focused range of issues - such as, for example, biodiversity, others address a broader array with their indicators falling into different thematic groupings. For example, PEMSEA has groups of indicators falling into categories including i) policy, strategies and plans, ii) institutional arrangements, iii) legislation, iv) information and public awareness, v) capacity development, vi) financing mechanisms, vii) natural and man-made hazard prevention and management, viii) habitat protection, restoration and management, ix) Water use and supply management, x) food security and livelihood management and xi) pollution and waste management.

5.11 Analysis of the indicator systems reviewed showed that, apart from some basic indicators such as, for example, fishing effort (appearing 10 times) and Chlorophyll (appearing 8 times) there was very little overall commonality. Even where the issue being addressed was essentially the same, slightly different approaches made commonality difficult to assess. For example, the 8 chlorophyll-related indicators are: 'chlorophyll concentration' (OSPAR), 'chlorophyll a' (CEP, BSC, TWAP, CAFF), 'Chlorophyll in transitional, coastal and marine waters' (EEA), 'Chlorophyll level' (BOBLME), 'Chlorophyll *a* concentration (area-specific) Elevated maximum and mean level' (OSPAR).

5.12 For some entities, the selection of indicators is driven by a clear political direction. For example, HELCOM's choice of indicators was derived from the decision to develop indicators with targets to follow-up both the implementation of the Baltic Sea Action Plan (BSAP)(HELCOM, 2007) and European Union Marine Strategy Framework Directive (MSFD) (European Union, 2008) (HELCOM, Case Study 3).

Case Study 3: Development of a core set of indicators HELCOM CORESET Project

Background

The objective of the HELCOM CORESET project is to produce indicators with targets to follow-up the implementation of the Baltic Sea Action Plan (BSAP) (HELCOM, 2007) and European Union Marine Strategy Framework Directive (MSFD)(European Union, 2008). An aim of the project is to develop HELCOM core indicators in such a way as to ensure coherence among them and coherence with the requirements of the MSFD to assess Good Environmental Status (GES)[17], taking account of the GES descriptors and the criteria and indicators for each descriptor contained in the European Commission Decision on criteria and methodological standards on GES (2010/477/EU, European Union, 2010).

The focus of the project is primarily on biodiversity and hazardous substances[18].The ultimate aim is for the proposed core indicators to be developed into operationalised, regularly monitored and updated indicator reports, providing assessment data utilisable in HELCOM assessments, and placed on the HELCOM website (HELCOM, 2012).

While assessments of the environmental status of the Baltic Sea have been carried out for many years, only the most recent thematic assessments have been based on quantitative indicators and environmental targets that reflect good environmental status.

Selection process

The HELCOM CORESET started with the premise that the approaches to be developed for the BSAP should also be applicable for the MSFD. The selection process began by close examination of the assessment requirements arising from the BSAP, MSFD and associated documents.

At the start of the project common principles for HELCOM core indicators and their quantitative targets were developed (Tables 1 and 2).

[17] 'good environmental status' means the environmental status of marine waters where these provide ecologically diverse and dynamic oceans and seas which are clean, healthy and productive within their intrinsic conditions, and the use of the marine environment is at a level that is sustainable, thus safeguarding the potential for uses and activities by current and future generations (MSFD, Article 3 [5]).

[18] Core indicators for eutrophication have been developed in a separate HELCOM Monitoring and Assessment Group process.

Table 1. Adapted from Table 2.1 (HELCOM 2012)Common principles for HELCOM core indicators, recalling HELCOM Monitoring and Assessment Strategy (MONAS), as well as the HELCOM Data and Information Strategy

1	**Compiled and updated by Contracting Parties**.
2	**Science-based**: Each indicator describes a scientifically sound phenomenon.
3	**Link to anthropogenic pressures**: Status indicators should be linked to anthropogenic pressures and indirectly reflect them, where appropriate, and additional pressure indicators are used and they directly reflect anthropogenic pressures and are tightly linked to human activities.
4	**Policy response**: The indicator measures part of or fully an ecological objective and/or a descriptor of good environmental status.
5	**Suitability with assessment tools:** The indicator can be used with the assessment tools but the assessment tools will be open for modifications as necessary.
6	**Suitability with BSAP/MSFD**, making best use of the synergies with other Directives and according to the HELCOM Monitoring and Assessment Strategy: The indicator reflects a component contained in the HELCOM system of the vision, goals and ecological objectives and/or MSFD descriptor.
7	**Qualitative or quantitative with a textual background report**: Indicators, either qualitative or quantitative, are numeric, based on measurements or observations and validated models; they must also have a quantitative target level reflecting the lowest boundary of good environmental status. They also contain a textual background report with interpretation of the indicator results
8	**Baltic Sea wide**: The HELCOM indicators should cover the whole sea area
9	**Commonly agreed**: The finalised indicators and their interpretation are commonly agreed among the HELCOM Contracting Parties and HELCOM MONAS is the HELCOM body that should approve the publication of the core indicator reports on the HELCOM web page.
10	**Frequently monitored and updated**: Data underlying the indicators are collected within the HELCOM coordinated monitoring and the indicator reports will be updated preferably annually or at intervals suitable for the measured factor.
11	**Harmonised methodology**: Data in an indicator will be collected using harmonised monitoring, quality assured analytical methods, as well as harmonised assessment tools, according to the relevant HELCOM guidelines or EU standards, such as methodological standards or guidelines for GES under the MSFD to be delivered by the EC, other relevant international standards.
12	**Confidence evaluation**: The indicator and the data must be assessed using common criteria and this confidence evaluation is to be included in the indicator report.

Table 2. Common principles for quantitative or qualitative targets of core indicators (Adapted from HELCOM, 2012)

1	**Targets need to be developed for each indicator separately**
2	**Purpose of the status targets:** The target reflects the boundary between GES and sub-GES. The boundary can be based on a specific score that can be derived through the use of an 'Acceptable deviation' from a 'Reference condition'.
3	**Purpose of the pressure targets:** The targets reflecting anthropogenic pressures should guide the progress towards achieving good environmental status.
4	**Science-based:** A target level should be based on best available scientific knowledge. In the absence of data and/or modelling results, expert judgment based on common criteria should be involved to support the target setting.
5	**Spatial variability:** Target levels can vary among sub-basins or among sites depending on natural conditions.
6	**Confidence** of the targets must be evaluated by common criteria and included in the general confidence evaluation of the indicator report

CORESET selection of GES boundaries (targets)

The principle objectives of both BSAP and MSFD are to achieve or maintain 'good environmental status. Both instruments give two status classes: GES and the status below GES (sub-GES). In the CORESET project, where possible, a single boundary for GES has been proposed for each indicator. The CORSET GES boundaries equate to the environmental targets of the MSFD. Boundaries for biodiversity may, for example, be set based on an acceptable deviation from i) a reference condition; ii) a fixed reference point/period; iii) a potential state; or maybe iv) based on the knowledge of physiological or population-related limitations; v) based on temporal trends; vi) adverse effects on the condition of an organism; vii) relations other taxa and environmental condition (HELCOM, 2013a).

GES of hazardous substances of CORESET core indicators is defined by various threshold levels which reflect ecotoxicological tipping points. The main thresholds are the European Union Environmental Quality Standards and the OSPAR Environmental Assessment Criteria, but CORESET also applied food safety limits and levels derived by scientific expert cooperation (HELCOM, 2013a).

CORESET indicator selection

The project was divided into two work packages, biodiversity and hazardous substances. The biodiversity group was further divided into six sub-groups focussing on Mammals, Birds, Fish, Pelagic habitats (including associated communities),Seabed habitats (including associated communities) and Non-indigenous species.

From an initial large number of potential indicators for biodiversity, the selection process began by identifying key species, functional groups and predominant habitats and screening human pressures on those. The same common principles were applied to selection of indicators for hazardous substances but with the addition of availability of thresholds for good environmental status and PBT properties, i.e., persistence in the environment, bioaccumulation in organisms and toxicity.

Biodiversity indicators

The selection of biodiversity indicators was based on a series of reports of the MSFD GES Task Groups (Cochrane et al. 2010, Olenin et al. 2010, Rogers et al. 2010, Rice et al. 2010), where necessary adapted to Baltic conditions; the HELCOM common principles of core indicators (Table 1) and the European Commission decision document (European Union, 2010).

The selection process was approached from three angles:

- functional groups and predominant habitats, including key species;
- impacts of anthropogenic pressures on the functional groups and predominant habitats; and
- availability of monitoring.

The functional groups and species groups to be used as basis for indicator selection were identified. Species groups comprised birds, mammals and fish while the functional groups included, for birds, a range of feeding strategies, two types of marine mammal and coastal, pelagic and demersal fish, elasmobranchs and anadromous/catadromous fish. Predominant habitat types in the Baltic were identified encompassing seabed habitats, pelagic habitats and ice associated marine habitats. In order to select appropriate indicator species for the functional groups and to identify indicator species for food webs Baltic key species were also identified. The criteria used to assemble the list were: "Species and/or groups important to the Baltic Sea ecosystem structure and function in terms of biomass, abundance, productivity, or functional role" (Descriptor 4, European Union, 2010).

The second criterion for the process was to identify the anthropogenic pressures on the functional groups and predominant habitats. A guiding document for the selection of indicators was produced, which took into account the MSFD GES criteria as well as the common principles of the HELCOM core indicators. A list of anthropogenic pressures was prepared and experts were asked to score the impact of each pressure on each functional group or habitat by a three-level score - low, intermediate, high - and distinguish direct impacts from indirect ones. The pressures perceived as having the highest impacts were identified and the results of the evaluation guided the selection of indicator parameters.

HELCOM monitoring programmes are directed mainly towards monitoring the effects of eutrophication and contaminants. Consequently, the availability of monitoring data was not a ruling criterion in the development of the core indicators for biodiversity. Instead, the principle was interpreted to apply to the operational core indicators after monitoring programmes had been revised according to the proposed core indicators.

An initial list of 45 biodiversity indicators was identified, all labelled 'candidate indicators'. A series of workshops subsequently categorised the indicators into core, candidate and supplementary indicators. Core indicators were categorised using the following criteria:

- the indicator should clearly represent a GES criterion and the HELCOM common principles for indicators (e.g. link to anthropogenic pressures);
- the indicator should be well-established or, if new, be tested and documented in a way that allows an external review of the proposal;
- include proposed GES boundary/boundaries; and
- monitoring should be in place or a proposal for future monitoring should be formulated.

The remaining candidate indicators were considered 'promising' yet 'not possible to operationalise' within the first phase of the CORESET project. It was anticipated, however, that some of the remaining candidate indicators would be reclassified during the second phase of the project. Indicators which clearly did not fit to the core indicator concept were categorised as 'supplementary indicators'. While not considered as core indicators there were seen as useful support material,

providing data on climatic and hydrographic changes, fluctuations of populations and changes in parameters which reflect human activities.

Hazardous substances indicators

Criteria were agreed for the selection of indicators based initially on needs rather data availability. The work was based on the principles of core indicators (Table 1). The selection criteria were:

- an alarming /increasing levels of the substance in the Baltic;
- PBT properties (persistence, bioaccumulation, toxicity);
- management status (banned, regulated, not banned);
- policy relevance (existing priority lists);
- the availability of targets;
- monitoring status.

A series of workshops eliminated or added substances as more information became available. The workshops also considered the inclusion of several parameters (i.e. congeners or substances) for a single core indicator. The congeners (or closely-related substances) often represent different pollution sources and, hence, provide important extra information to the indicator.

Indicators of the effects of hazardous substances were also included. The working groups aimed to cover different contaminant groups by these core indicators; different response levels in organisms; and most mature indicators scientifically.

Geographical scales

The size of the assessment units and the scale for which GES boundaries should apply are parameter dependent. The following aspects were to be considered when defining the assessment units for the biodiversity indicators:

- a suitable assessment unit for an indicator, based on ecological relevance, i.e. scales of variability in ecosystem components;
- suitable geographical boundaries within which GES applies to an indicator; and
- an assessment unit for an integrated assessment.

Current status of HELCOM CORESET Indicators

The 41st meeting of the HELCOM Heads of Delegation (HELCOM HOD 41/2013), which was held on 17-18 June 2013, agreed on the publication of the following 25 core indicators (Table 3), with the acknowledgement that they will be further developed by the CORESET II project and that the Good Environment Status boundaries of the core indicators are provisional and will also be further developed by the HELCOM CORESET II project.

Table 3 HELCOM CORESET core indicators

Population growth rates, abundance and distribution of marine mammals
Pregnancy rates of marine mammals
Nutritional status of seals
Number of drowned mammals and waterbirds in fishing gears
White-tailed eagle productivity

Abundance of waterbirds in the wintering season
Abundance of waterbirds in the breeding season
Abundance of key fish species
Abundance of fish key functional groups
Proportion of large fish in the community
Abundance of sea trout spawners and parr
Abundance of salmon spawners and smolt
Zooplankton mean size and total abundance
State of the soft-bottom macrofauna communities
Population structure of long-lived macrozoobenthic species
Trends in arrival of new non-indigenous species
Red-listed benthic biotopes
Polybrominated biphenyl ethers (PBDE): BDE-28, 47, 99, 100, 153 and 154
Hexabromocyclododecane (HBCD)
Perfluorooctanesulphonate (PFOS)
Polychlorinated biphenyls (PCB) and dioxins and furans: CB-28, 52, 101, 118, 138, 153 and 180; WHO-TEQ of dioxins, furans +dl-PCBs
Polyaromatic hydrocarbons and their metabolites: US EPA 16 PAHs / selected metabolites Metals
(lead, cadmium and mercury)
Radioactive substances: Caesium-137 in fish and surface waters
Tributyltin (TBT) and imposex

HELCOM HOD 41/2013 also took note of the following set of pre-core indicators (Table 4) which are to be further developed during 2013-2015 by the HELCOM CORESET II project along with the candidate indicators in such a way that they will be developed into core indicator proposals for consideration by HELCOM MONAS, HELCOM GEAR and HELCOM HOD by mid-2015.

Table 4 Indicators to be further developed

Lower depth distribution limit of macrophyte species
Number of waterbirds being oiled annually
Cumulative impact on benthic habitats
Extent and distribution of benthic biotopes (in preparation)
Pharmaceuticals: Diclofenac, EE2 (+E1, E2, E3 + in vitro yeast essay)
Lysosomal Membrane Stability - toxic stress indicator
Fish diseases- fish stress indicator
Micronuclei test- genotoxicity indicator
Reproductive disorders: Malformed eelpout and amphipod embryos

Indicators of anthropogenic pressure

The CORESET core indicators represent indicators on state (for biodiversity) and pressures or impacts (for hazardous substances and eutrophication. The common principles for HELCOM core indicators (Table 1) require that the core indicators are expected to have links to anthropogenic pressures and indirectly reflect them. The CORESET project considered the linkages between the proposed core indicators to human pressures and identified pressures that are linked to the core indicators (see Chapter 3, HELCOM, 2012). Listing potential human pressure core indicators is essential when identifying measures to be included into the Programme(s) of Measures and work to develop a core set of human pressure indicators in support of programmes of measures is ongoing (HELCOM, 2013b).

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State of the Environment v Progress reporting

5.13 The emphasis of the categories of indicators being used varies but broadly there is a distinction between:

1. Regional Seas Conventions and Action Plans where the emphasis is on State of the Environment. Here it is predominantly water quality and living/non living resources that dominate the indicator suites together with associated management indicators. (Black Sea, Case Study 4.)

Case Study 4: The Black Sea

Through its Permanent Secretariat, the Commission on the Protection of the Black Sea Against Pollution (BSC) is the intergovernmental body established to implement the Convention on the Protection of the Black Sea Against Pollution (Bucharest Convention), its Protocols[19] and the Strategic Action Plan for the Environmental Protection and Rehabilitation of the Black Sea. The latest version of the SAP was adopted in 2009[20], replacing the earlier, 1996[21], version.

A State of the Environment Report is produced every 5 years and is linked to a further report, Report on the Implementation of the Black Sea Strategic Action Plan (BSSAP). To date, two such assessments have been undertaken (in 1996[22] and 2007[23]). A third is on-going. The aim of the diagnostic reports is to update the BSSAP. The last diagnostic report, elaborated in 2010[24], focussed on improvement to the regular reporting process on the state of the Black Sea environment.

The basis of the 1996 SAP was policy actions whereas the 2009 SAP was based around Ecosystem Quality Objectives (EcoQOs) (Table 1) and respective management targets to achieve the four established EcoQOs. The 2009 SAP arose through consensus reached at a multinational level in relation to a series of proposals that include: Ecosystem Quality Objectives; short, medium and long term targets; and legal and institutional reforms and investments necessary to solve main

[19] Protocol on the Protection of the Marine Environment of the Black Sea from Land-Based Sources and Activities (2009) [entry into force pending]

Protocol on Protection of the Black Sea Marine Environment Against Pollution from Land Based Sources (1992)Protocol on Cooperation in combating pollution of the Black Sea Marine Environment by Oil and Other Harmful Substances in Emergency Situations

Protocol on The Protection of The Black Sea Marine Environment Against Pollution by Dumping

Black Sea Biodiversity and Landscape Conservation Protocol to the Convention on the Protection of the Black Sea Against Pollution

[20] http://www.blacksea-commission.org/_bssap2009.asp#_Toc222222296

[21] http://www.blacksea-commission.org/_bssap1996.asp

[22] http://www.blacksea-commission.org/_publ-SOE2002-eng.asp

http://www.blacksea-commission.org/_publ-BSSAPIMPL2002.asp

[23] http://www.blacksea-commission.org/_publ-SOE2009.asp

http://www.blacksea-commission.org/_publ-BSSAPIMPL2009.asp

[24] http://www.blacksea-commission.org/_publ-BSDiagnosticReport2010.asp

environmental problems identified within the 2007 Black Sea Transboundary Diagnostic Analysis (BS TDA)[25] .

The BSSAP 2009 (Annex 4) outlines three sets of Monitoring and Evaluation (M&E) indicators (proposed by GEF) to measure the implementation of SAP: process indicators, stress reduction indicators and environmental status indicators. These indicators will be used in the assessment of the implementation of the BSSAP 2009, which will be completed provisionally in 2015.

Table 1. The four Black Sea EcoQOs and associated Sub EcoQOs (BS SAP, 2009)

EcoQO	Sub EcoQO
1. Preserve commercial marine living resources.	1a: Sustainable use of commercial fish stocks and other marine living resources. 1b: Restore/rehabilitate stocks of commercial marine living resources.
2. Conservation of Black Sea Biodiversity and Habitats.	2a: Reduce the risk of extinction of threatened species. 2b: Conserve coastal and marine habitats and landscapes. 2c: Reduce and manage human mediated species introductions.
3: Reduce eutrophication.	
4: Ensure Good Water Quality for Human Health, Recreational Use and Aquatic Biota.	4a: Reduce pollutants originating from land based sources, including atmospheric emissions. 4b: Reduce pollutants originating from shipping activities and offshore installations.

Monitoring

The Black Sea Information System (BSIS) and Black Sea Integrated Monitoring and Assessment Program (BSIMAP) are responsible for providing data for 'state of the environment' reporting, 'impact assessments' of major pollutant sources, 'transboundary diagnostic analysis' and SAP implementation reports (BSSAP process).

The general requirements for data and monitoring systems within the region have been formulated on the basis of EEA methodologies for indicators calculation and on specific needs to meet the obligations of the MSFD in EU-member states (BSC, 2010). The most relevant international policies and agreements in terms of monitoring the Black Sea and reporting are considered to be not only the SAP (adopted in 2009), but attempts have also been made to harmonize approaches and principles with the Water Framework Directive (WFD) and Marine Strategy Framework Directive (MSFD) (BSC, 2010).

An analysis of the reporting process on the State of the Black Sea Environment in relation to the requirements of the various legal and policy documents (BS SAP, MSFD and EEA) was undertaken by BSC[26]. The report identified shortcomings in the existing indicators to meet the requirements of the

[25] http://iwlearn.net/iw-projects/397/reports/bserp-tda/view

[26] The Diagnostic Report' to guide improvements to the regular reporting process on the state of the Black Sea environment, 2010 (The Diagnostic Report)

MSFD, EEA and SAP and proposed recommendations. These are summarised below in a series of tables (Tables 2 - 7).

Table 2. Summary table of suitability of Black Sea indicators to meet MSFD, EEA and SAP requirements
(adapted from Section III, BSC, 2010)

INDICATOR	COMMENTS
Eutrophication indicators (inorganic nutrients, chlorophyll and N/P ratio)	N/P is not specifically reported to the BSC but as a generic indicator it can be easily derived from the Black Sea Information System (BSIS). Chlorophyll is poorly reported to the BSC and the data cannot be used for a regional assessment. Outside the BSIS, Chlorophyll data are available and suitable to build trends and maps of spatial distribution. Nutrients data in BSIS is suitable to trace trends and spatial distribution in coastal waters, but not in the open-sea.
Expansion of hypoxia zones (BSC and MSFD indicator)	Cannot be traced based on BSIS data, however, data are available in the region.
Harmful algal blooms (MSFD indicator)	BSIS data not enough to support this indicator, however, external data are sufficient for regional assessments.
Primary production (MSFD indicator)	Not regularly studied in the Black Sea. There are no data in BSIS, and outside of BSIMAP different methods are used to measure primary production, therefore the data are not suitable for comparisons.
Hazardous substances in biota, sediments (BSC, EEA, MSFD indicators) and their effects (MSFD indicator)	Studied in the Black Sea sporadically but the data are not sufficient for regional assessments yet.
Discharge of oil from refineries and offshore installations (EEA indicator	Not reported to the BSC, there is no information on the availability of data in the region.
Illegal discharges of oil from ships (BSC, EEA indicator)	Are considered, however verification of spills (aerial surveillance, for instance) is still poorly provided by states.
Pollutant loads (BSC, MSFD)	Well reported to the BSC, data are sufficient for hot spots and rivers.
Marine Litter (MSFD)	Not a component of the BSIMAP. Data outside BSIS are available, however, assessments are possible for ML on the coast, but not in the sea or seafloor.
Most BSC Biodiversity indicators are also EEA and MSFD indicators	Data supporting those indicators for macroalgal communities in the BSIS are limited. For seagrassess data are not reported in BSIS. Outside BSIS - available and suitable for building indicators.

Marine Protected Areas (MPAs)	MPAs are well reported to the BSC, together with threatened and protected species.
BSC Fishery indicators (also as EEA and MSFD indicators)	Well reported to the BSC, however, stock assessments for most of the fish species are in need for harmonization.
Northward movement of species (EEA)	Not reported to the BSC, however, scientific studies in the region are available.
Invasive species diversity and abundance (BSC, MSFD)	Poorly reported to the BSC. Data outside of BSIS are suitable for the indicators calculation.
Bathing waters	Data are regularly collected in all Black Sea states, data outside of BSIS are sufficient for tracing compliance with established standards but not yet harmonized in the region.

Table 3. Summary table of reasons for gaps in reported data (adapted from Section III, BSC, 2010)

Lack of integrated monitoring
Recommended frequency of observations not always observed
Mandatory parameters are often not covered
Open-sea stations are missing - no agreed stations for a regular monitoring
Reference stations - mainly missing or not specified as such, except Romania
Long-term time series data stations lack special attention and permanent financial support Poor
coordination between responsible authorities
Poor financial assistance, in general
Regional dimension absent
BSIMAP stations are mainly coastal, very few marine stations
Monitoring does not use much automated systems and other modern tools of observations Lack of
harmonization (especially in fisheries)

The gaps in reporting identified above are directly related to the gaps in national monitoring programmes. The reasons for such gaps vary between states (Table 4).

Table 4. The main problems identified by states for gaps in reporting of data (adapted from Section III, BSC, 2010)

Lack of an established national monitoring programme Lack of
integration
Poor coordination between responsible organisations Lack of
(stable) financial assistance
Overlapping activities

Too many organizations involved in monitoring
Complicated structure for national monitoring programme
Insufficient frequency of observations
Better integration for some components of monitoring programme required

Following the gap analysis a range of recommendations were proposed (Table 5).

Table 5. Summary table of recommendations to improve monitoring activities (adapted from Section III, BSC, 2010)

Recommendations for improving of monitoring activities	
BS Monitoring Strategy for 2011-2020 should further develop the existing practices (filling the gaps in observations as already agreed, improve geographical coverage, etc.) and encompass new issues as well as the development of new methodologies and tools.	Issues of particular importance: (a) relation to climate change and climate change policies; (b) development of tools for integrated regional assessment of BS state (simultaneous observations in all countries, including cruises for Marine Living Resources (MLR) stock assessments, etc.); (c) regular open sea observations; (d) development of networks (reference stations, trends stations/transects in transitional, coastal and marine waters, marine mammals strandings and by-catch, etc.); (e) cumulative effects and transboundary environment problems; (f) screening for new pollutants; (g) pollution incidents; (h) habitat mapping; (i) ballast water monitoring; (j) air pollution (or contract with EMEP); (k) marine litter; (l) hazardous substances transportation and others.
Creation of network of reference sites and stations with levels of organization	3
Revisions for the present BSIMAP monitoring strategy	Exclusion of contaminants monitoring in water. Replaced by contaminants monitoring in biota and sediments to detect temporal trends.
Improvement and harmonization of methodologies used in the BS region to assure compatibility of data collected.	
New observation techniques need to be developed	
Build on international agreements under the umbrella of the BSC for joint ventures based on common (and	BS pilot programmes in all states' waters undertaken in a harmonized way

transboundary) environmental problems to find regional solutions	and transboundary problem-driven. For example: 1. Fish and other marine living resources stock assessments 2. Cetaceans surveys 3. Marine Litter in the sea 4. Contamination of sediments and biota 5. Habitats mapping, biodiversity assessments, etc.
Supporting activities	
	Utilization of the capacities of all Institutes dealing with monitoring in the region. Bi-lateral and multi-lateral agreements to be developed
	Avoiding overlapping of activities and efforts
	Partnership with international organizations - EEA, IMO, ESA, EMSA, HELCOM, utilizing their experience
	Capacity building
	Sharing. The data flow and dissemination of information (prepared reports based on data collected) within BSC as well as from BSC should be transparent, two-way and easily accessible by everybody

Table 6. Summary table of recommendations to improve the reporting process (adapted from Section III, BSC, 2010)

Recommendation to improve the reporting process	
The network of reporting institutions in the Black Sea should be further developed	Reporting to the BSC should be fully reorganized to encompass as much as possible the data collected in an integrated manner. Network of Monitoring stations and sites to be improved on the basis the 3 levels of organisation
Regional data base (BSIS) should be proposed as the permanent domain for any data in the region produced by projects	
MSFD, Annex I descriptors	Marine biology, incl. biodiversity conservation and habitats data reporting, needs improvement and further development to meet the requirements of the evaluations, envisaged in the MSFD.

Almost all the EEA core set of indicators are already in use in the BSC and the EEA methodologies

for calculation of indicators are already in use in Black Sea region and no recommendations for improvement were made. However, in the context of the Black Sea, a number of alterations to indicators are proposed (Table 7).

Table 7. Recommendations to improve the existing EEA indicator specifications, proposals for new indicators (adapted from Section III, BSC, 2010)

Nutrients and chlorophyll	Different seasons for data collection recommended: Winter and spring, surface waters of the Black Sea are enriched with nutrients, therefore spring data should also be considered for aggregation and indicator evaluation. Surface values alone of chlorophyll may not be enough because of occurrence of deep chlorophyll maximum, seasonal surface maximums are different.
More indicators to be considered for use in the Black Sea	S/W
	Fatness of sprat
	Positioning of the Cold Intermediate Layer
	Organic nitrogen could be tested as indicator, where long term data is available
	Nutrients in sediments could be a valuable indicator of secondary eutrophication

Further recommendations addressing MSFD 'forward looking' component propose standardized methods of monitoring and assessment and harmonization of monitoring strategies, improved integration and coordination across the region.

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2. Progress reporting was exemplified by thematic frameworks developed for projects such as the large marine ecosystem projects (TWAP and Bay of Bengal LME project, Case Study 5). The TWAP framework allows for differentiation between different systems (river basins, lake basins, aquifers, large marine ecosystems and open oceans. The framework provides a basis for a common terminology (Tables 1 and 2 in Case Study 5) with the additional benefit that most parameters are relatively easy to monitor/collect requiring, for example limited sea time.

   The indicators can be further developed in terms of progress monitoring and performance reporting by a specific region e.g. the BOBLME (See Case Study 5) and others such as ATSEA monitoring against SAP targets.

Case Study 5: Transboundary Waters Assessment Programme (LMEs and Open Ocean systems) and Bay of Bengal LME (BOBLME) Project application of TWAP

Background

The Global Environment Facility (GEF) Medium-Sized Project (MSP), Development of the Methodology and Arrangements for the GEF Transboundary Waters Assessment Programme (TWAP) ran over a two-year period from 2009 to 2011. The project arose out of the need for a systematic and scientifically robust methodology and institutional arrangements for assessing the changing conditions of transboundary water systems (groundwater aquifers, lakes/reservoirs, river basins, LMEs, and open ocean areas) resulting from human and natural causes (UNEP, 2011).

The Project Objective was to develop the methodologies for conducting a global assessment of transboundary waters for GEF purposes and to catalyse a partnership and arrangements for conducting such a global assessment (UNEP, 2011).

Building on lessons learned from the Global International Waters Assessment (GIWA, Case Study 7) which designed a single integrated methodology for the global assessment of international waters, TWAP working groups developed five distinct methodologies, tailored for the respective water systems. This was deemed necessary given the differences in physical nature, data availability, and assessment unit sizes within each system. Furthermore, with varying levels of existing knowledge of the five water systems at the global scale, the methodology depends on the starting point of each system. Nevertheless, where possible, synergies between the methodologies were identified (UNEP, 2011).

Conceptual frameworks

The aim of the assessment methodology was to evaluate human and ecosystem uses of water resources, highlighting current states and showing levels of system impairment. This required the development of indicators that describe and quantify states, processes and stress factors at water system scale, as well as those that capture the social, economic and governance factors associated with human appropriation of water systems (UNEP, 2011a). While the methodologies and assessments were developed and implemented independently for the five transboundary water systems, the interlinkages among them were, where practicable, addressed by common indicators.

The common indices were based on system connectivities within a common hydrologic cycle that has been modified by human use, and which form critical components in assessing present and future water system states. In addition, the methods enable projections of the environmental status and use of water resources to be made to 2030 and 2050. It was anticipated that contemporaneous assessments and future projections should allow for targeted policy interventions to mitigate system

degradation and prevent irreversible collapse in the near and long terms (UNEP, 2011). TWAP

assigned two levels of assessment:

Level 1: a global baseline assessment for each of the five water systems, with some projections to 2030 and 2050.

Level 2: a more detailed analysis of a small selection of transboundary units within each water system, building on existing analyses such as Transboundary Diagnostic Analysis (TDA) and including a causal-chain analysis, identification of hot spots and clarification of interlinkages between water systems. The Open Ocean Level 2 assessment involved the impact of open ocean conditions on specific locations.

LMEs: A conceptual framework was developed for assessing LMEs that focussed on human/environment interactions that cause changes in ecosystem state and ecosystem services, and alter the vulnerability of human communities and ecosystems to external perturbations.

The unit of assessment was each of the 64 LMEs as delineated by Sherman (1994) and the Pacific Warm Pool. In addition transboundary deltas were included.

Four categories of indicators were assigned to assess LMEs: (1) transboundary stress indicators, (2) transboundary environmental status indicators, (3) socioeconomic indicators (indicators of anthropogenic drivers of ecosystem change and socioeconomic impacts of these changes), and (4) governance/policy response indicators. As the coastal boundaries of most LMEs belong to more than two coastal states, LME assessments require aggregating national indicators to describe LME-scale phenomena. However, nutrients and mercury are cross-cutting issues, particularly between LMEs and Rivers.

Assessment of the 64 LMEs and the Pacific Warm Pool is planned for level 1 of the FSP, which will be a global comparative baseline assessment of current LME state and stressors as well as future projections to 2030 and 2050 of key stressors and likely impacts using indicators within the five LME modules: (i) productivity; (ii) fish and fisheries; (iii) pollution and ecosystem health; (iv) socio-economics; and (v) governance. Smaller assessment units within LMEs will also be considered. These will include particular habitats, including coral reefs, mangroves, seamounts, and deltas, which will be assessed and reported by LMEs as well as across LMEs in a global comparative analysis. Transboundary hot spots will also constitute a smaller assessment unit within LMEs and are to be identified during the assessment. Mapping the cumulative human impact on LMEs is also proposed, following the approach of Halpern et al. (2008) - which would also serve to validate the results of the Level 1 comparative assessments (UNEP, 2011).

Open Ocean: As governance of human activities in the open ocean is thematic, thematic issues were identified for assessment. Also, the oceans comprise very different ecosystems which cover distinct regions. Consequently four major themes were assigned: (1) climate change, variability, and impacts; (2) ocean ecosystems, habitats and biodiversity; (3) open ocean fisheries; and (4) pollution. Crosscutting issues included the assessment of global ocean policy cycles and their links with regional and national arrangements, and the underpinning observational, and governance capabilities to support their implementation.

Implementing the Open Ocean assessment requires two major activities: (1) mapping of indicators; and (2) expert assessments. It was considered that an assessment approach based exclusively on metrics, indicators, and indices was not feasible for the open ocean due to a lack of data.

Instead, expert assessments would be carried out to review and assess the most recent scientific,

technical and socio-economic information produced worldwide and relevant to the understanding of human wellbeing connected to the open ocean through ecosystem services and direct impacts. The assessment allows for the identification of particular geographic areas of current and future concern. To complement the global Level 1 analysis, a Level 2 analysis focuses on one specific region, and identifies how the open ocean environment remotely impacts the wellbeing of a local human population.

Common elements, interlinkages and cross cutting issues: A core set of indicators addresses socio-economic and governance issues for the five transboundary water system assessments. A group of economic indicators quantify the Gross Domestic Product (GDP) generated by water ecosystem services and the vulnerability of economic activities in relation to climate-related natural disasters. Human wellbeing is quantified by a suite of social indicators, providing measurements of access to improved drinking water and sanitation, for example, and of vulnerability of human populations to climate-related natural disasters. Lastly, the evaluation across all water systems of the presence or absence of governance architecture to address water issues provides a governance index. In addition, all water systems assessments, other than that for transboundary aquifer systems, address nutrients and mercury.

Cross cutting issues for LMEs relate primarily to LME interaction with open ocean and rivers, and to a certain extent, aquifers through saline intrusion. Evaluation of nutrient fluxes from rivers (outflows) to coastal areas of LMEs (inputs) was identified as a requirement. Transboundary deltas were identified as of particular importance in assessing interlinkages between LMEs and rivers. Sea level rise (Open Ocean) and its impacts on coastal areas and human communities adjacent to the LMEs were similarly identified for assessment of interlinkages.

For Open Ocean, the primary connectivity in terms of water and material transfer was identified as via the atmosphere while those with other water systems as secondary. Present and projected future impact of Nutrient input and mercury will be estimated from models.

Indicators

Most Working Groups involved in the development process of TWAP identified three levels of indicator with generally increasing complexity and aggregation (UNEP, 2011, p.20):

- metric: e.g., GDP per capita. Metrics usually have units;
- indicator: generally a combination of two or more metrics (e.g., economic dependency on water
- resources). Indicators may or may not have units, depending on how they are formed;

index: a combination of two or more indicators (e.g., socioeconomic index). Indices are generally dimensionless and usually have normalized scores. Stakeholder feedback during the process stressed the importance of transparent criteria for the weighting of each metric or indicator in forming indices.

Table 1 LME 'current' indicators. Projections to be made where possible (Adapted from UNEP, 2011)

Productivity	Fish & Fisheries	Pollution & Ecosystem health	Socioeconomics	Governance
(1) Primary productivity; (2) Chlorophyll	(4) Reported landings; (5) Value of	(9) Mercury; (10) Nutrients; (11) PoPs (Plastic	(18) GDP fisheries; (19) % GDP international	(23) Institutional arrangements

a; (3) Sea surface temperature	reported landings; (6) Mean Trophic Level Index (MTI) and Fishing in Balance Index (FiB); (7) Ecological Footprint of Fisheries; (8) Stock-status plots;	resin pellets); (12) Shipping density; (13) Seamounts at risk; (14) Change in Protected Area coverage; (15) Change in extent of mangrove habitat; (16) Reefs at risk index; (17) Deltas at risk index;	tourism; (20) Urban and rural populations living within 10 m coastal elevation; (21) HDI; (22) Deaths per 100,000 caused by climate related natural disasters; and	

Table 2 Open Ocean indicators. C&P stands for current and projected (2030 and 2050) (Adapted from UNEP, 2011)

Climate change, variability, and impacts	(1) sea level (C&P) (2) ocean heat storage (including impact on corals, extremes, and primary productivity (3) rainfall-drought changes linked to ocean (4) sea ice (5) ocean deoxygenation (C&P) (6) ocean uptake of carbon dioxide (CO2) (C&P) (7) ocean acidification (C&P).
Ocean ecosystems, habitats, and biodiversity	(8) primary productivity (9) zooplankton (10) food web/trophic level changes (11) ecologically and biologically significant areas (12) seamounts at risk (13) ecosystem service valuation.
Open ocean fisheries: impacts and sustainability	(14) demersal fishing effort (15) open ocean fisheries sustainability (16) fish catch value
Pollution as stressor of marine ecosystems	(17) shipping (18) plastics (19) seabed mining (20) nutrient inputs (atmospheric) (21) mercury input (atmospheric) (22) pollution watch
Cross-cutting assessment of governance	

Scoring indicators

Similar approaches to scoring of indicators were devised for all water systems. Importantly, scoring systems should be transparent and understood by end users. Indicators were generally to be presented in relative scoring categories to meet the objective of TWAP for creating a basis for comparison between transboundary units.

The relative scoring approach for LMEs comprised five asymmetric categories from one to five. The rationa le behind the 'asymmetrical' categories being to try to highlight those LMEs at greatest risk from existing and projected stressors or showing the highest level of degradation based on the relevant status indicators (IOC-UNESCO, 2011).

For the Open Ocean a relative scoring approach based on a mapping of cumulative human impact was devised with the expert assessment providing an independent check.

The indicators in Tables 1 and 2 have the advantages that they provide commonality across projects, they are relatively easily collected and can be further developed in terms of progress monitoring/performance reporting by a specific region.

Bay of Bengal LME

During the development of indicators, the Bay of Bengal LME Project decided to adapt the TWAP methodology, specifically the indicators, for inclusion in the SAP (BOBLME, 2012a). The indicators selected have been expanded and are used to measure performance against a range of EcoQOs (Table 3).

Table 3. BOBLME Project EcoQOs and indicators based TWAP methodology (BOBLME, 2012a; BOBLME, 2012b; BOBLME, 2012c)

EcoQO	Indicators
Coastal and marine pollution and water quality are controlled to meet agreed standards for human and ecosystem health	Percentage of household and industrial areas /hotels covered under sewage/waste water management network and septic systems
	Compliance with water quality standard
	Faecal coliform bacteria in coastal marine waters (MPN/100 ml)
	BOD (mg/l) levels according to national standards
	Dissolved organic loads
	Percentage of untreated sewerage discharge;
	Contaminate seafood incidences
	Quantity of marine litter (per length of coastline)
	Number of collection centers/ facilities
	Proportion of waste recycled resulting in decreased proportion of solid waste for disposal by landfill or incineration
	Reduction in annual marine mammal/birds deaths due to marine litter
	Number and effectiveness of awareness campaigns
	Perception of aesthetic / clean beach
	Water quality parameters related to cleanliness
	Water quality relating to nitrogen components (NO3, NO2, NH3) and phosphorous v standards

		Fertilizer use (perhaps a proxy, e.g. nitrogenous fertilizer imports, sales, application/unit area, etc.)
		N:P ratio
		Occurrence of Red tides, HAB (Frequency and area cover)
		Degree and coverage of eutrophication, including hypoxia and anoxia
		Chlorophyll level
		Frequency and magnitude of fish kills and other mass mortalities
		ORP and pH level (at different stages of eutrophication)
		Water transparency
		Nitrification/de-nitrification
		COD/BOD
		Number and effectiveness of oil spill contingency plans
		Concentration of total hydrocarbon contents in contents of marine and coastal water
		Concentration of PAH (polyaromatic hydrocarbons) in coastal waters
		Incidences of mass mortality of fish and other marine organisms (due to oil contamination)
		Oil slick along the coastline
		Number of tar balls on beach
		Number and magnitude of oil spill accidents
		Oil and grease in coastal sediment concentration data
		Quantity of POPs and PTSs used in agriculture
		Quantity of PTSs produced by disposal of plastics by burning Use of
		PCB
		Quantity of POPS (pesticides) in stock piles of POPs (Pesticides) as per the implementation plan
		(NIP) mandated by Stockholm Convention
		Level of POPs in fish tissues, poultry products and human bloods
		Level of POPs in coastal sediments especially in harbours and at disposal sites
		Bio-magnification and bioaccumulation of POPs and PTS in fishery products
		Sedimentation rates at selected critical habitats
		Sedimentation input from various sources, including rivers
		Number and effectiveness of management plans

	Water quality parameters (turbidity)
	Area of forest
	Status of beach processes like erosion and accretions along the coastline
	Water quality parameters (heavy metal concentrations)
	Concentration of heavy metals in biota (indicator organisms such as shellfish - “musselwatch” - programme)
	Quantity of heavy metal content (TBT/ Cu) in paints used as anti-fouling
Fisheries and other marine living resources are restored and managed sustainably	Total annual catch and fishing effort
	Catch rate (CPUE)
	Biomass
	Mean size of fish landed
	Mean Trophic Level of the catch (MTI)
	Catch landings (e.g. selected indicator species)
	Biomass of higher trophic level species
	Landed Catch Value
	Energy flow in the given ecosystem
	Size composition of species caught
	Percentage of juveniles in the catch
	Fishing effort by gear type
	Biodiversity index /Species diversity
	Number of destructive fishing gear in use
	Population of endangered species (e.g. whale shark, dugong, sea turtle, dolphins and whales)
	Mortality of endangered species (number killed per year)
Degraded, vulnerable and critical marine habitats are restored, conserved and maintained	Total area of live mangrove extent
	Profile of mangrove forests, including size of mangrove plant species
	Total area (or %) of mangrove under protected area management
	Ratio of Species diversity index from restored area to existing mangrove habitat
	Biodiversity indices of mangroves and associated species
	Improved Coastal Water quality (water quality index)
	Percentage or extent of live coral cover maintained
	Proportion of coastal areas with Ecosystem Approach to Fishery Management projects and programs
	Percentage / area of coral reefs under appropriate form of sustainable management, including percentage of coral reefs protected (MPAs)

	Biodiversity indices of corals and associated species (keystone and indicator species)
	Reefs at risk index
	Region wide early action for climate adaptation plan for the near shore, marine and coastal environment developed and implemented
	Number of policies, laws, agreements or regulations on climate change adaptation proposed, adopted and implemented
	Number of institutions designated to address climate change adaptations coordinated with national governmental support
	Value / funding /leveraged through Sustainable financing schemes/ mechanisms and private sector participation
	Extent (area) of seagrass habitats
	Percentage of sea grass area under protection/management
	Biodiversity indices of seagrass and associated species (indicator species)

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UNEP, 2011. L. Jeftic, P. Glennie, L. Talaue-McManus, and J. A. Thornton (Eds.). Methodology for the GEF Transboundary Waters Assessment Programme. Volume 1. Methodology for the Assessment of Transboundary Aquifers, Lake Basins, River Basins, Large Marine Ecosystems, and the Open Ocean, UNEP, x+60 pp.

Level of sophistication

5.14 While other entities have developed indicators incorporating the DPSIR or PSR categories (for example the Black Sea Commission), the most developed approach is that of the European Environment Agency (Case Study 6) which provides comprehensive scientific underpinning for each indicator. For example, the EEA core indicator CSI 023 'Chlorophyll in transitional, coastal and marine waters' provides justification for the indicator selection. This includes an explanation of pollution-pathways, elevated nutrient concentrations and the resulting eutrophication. It explains that the primary effect of eutrophication is excessive growth of plankton algae, which increases the concentration of chlorophyll-a. It goes on to describe the negative effects of eutrophication. An explanation of how chlorophyll a can be used to estimate phytoplankton biomass is provided as well as its use in assessing the effectiveness of measures to reduce eutrophication. An explanation of the use of ocean colour to measure chlorophyll a concentrations is also included as are links to the scientific references.

Case Study 6: European Environment Agency Indicators

Background

The European Environment Agency (EEA) is an agency of the European Union. As a major source of environmental information to both policymakers and the public, the EEA aims to deliver timely, targeted, relevant and reliable information. Environmental indicators play a key role in this.

The EEA currently maintains a set of over 242 environmental indicators[27] across 23 environmental topics (Table 1). Indicators are accessible and searchable via the EEA webpages[28].

Table 1.Environmental Topics covered by EEA indicators

Topic	No. of indicators	Topic	No. of indicators
Agriculture	11	Industry	8
Air pollution	18	Land use	3
Biodiversity	35	Natural resources	2
Chemicals	5	Noise	1
Climate change	55	Policy instruments	1
Coasts and seas	11	Soil	2
Energy	45	Tourism	4
Environment and health	7	Transport	45
Environmental scenarios	44	Urban environment	2
Fisheries	5	Waste and material resources	7
Green economy	3	Water	22
Household consumption	3	Total	242

Most of the indicators are explicitly designed to support environmental policies, based on data compiled by EEA, as well as statistics from other international organisations.

[27] As of 16 July 2013 the EEA maintains 242 indicators

[28] http://www.eea.europa.eu/data-and-maps/indicators/#c5=&c7=all&c0=10&b_start=0

EEA indicators are developed against the Driving force, Pressure, State, Impact, and Response (DPSIR) assessment framework. Such a framework provides structure when considering interactions between the environment and socio-economic activities. It is used to help design assessments, identify indicators, and communicate results and can support improved environmental monitoring and information collection (EEA 2012) (see Chapter 1).

As well as the DPSIR classification, EEA indicators can also be classified according to their type (Table 2).

Table 2. EEA Indicator type (EEA, 2012)

A	Descriptive indicators	'What's happening?'
B	Performance indicators	'Does it matter?' 'Are we reaching targets?'
C	Efficiency indicators	'Are we improving?'
D	Policy effectiveness indicators	'Are the measures working?'
E	Total welfare indicators	'Are we on the whole better off?'

Information on each indicator comprises comprehensive background material, dates published and modified, older versions, EEA topics and tags under which it falls, temporal and geographical coverage, DPSIR and typology. The key policy question and key messages relating to the indicator are provided together with data sources, scientific references, justification for indicator selection, further information about the indicator and contacts and ownership. A comments section is also available to view or contribute to via a European Environment Information and Observation Network (Eionet)[29] password.

Core Set Indicators:

In 2004, the EEA identified a core set of 37 indicators (CSI). The purpose of the CSI is to i) prioritise improvements in the quality and coverage of data flows, which will enhance comparability and certainty of information and assessments; ii) streamline contributions to other indicator initiatives in Europe and beyond and iii) provide a manageable and stable basis for indicator-based assessments of progress against environmental policy priorities (EEA, 2005).

The establishment and development of the EEA CSI has been driven by the need to identify a small number of policy-relevant indicators that are stable, but not static, and that answer selected priority policy questions. However, to be fully effective in environmental reporting the CSI need to be considered alongside other information (EEA, 2005).

The CSI covers six environmental themes (air pollution and ozone depletion, climate change, waste, water, biodiversity and terrestrial environment) and four sectors (agriculture, energy, transport and fisheries). CSI indicators are predominantly indicators of Pressure (P) and State (S) and are descriptive (A) or performance (B) based (Table 3).

[29] European Environment Information and Observation Network http://www.eionet.europa.eu/

Table 3 EEA Core set of indicators by DPSIR framework and type (source: Annex 3, EEA, 2005)

	D	P	S	I	R	A	B	C	D	E
Air quality and ozone depletion		4		2			6			
Biodiversity			1	1	1	3				
Climate change		2	2			1	3			
Terrestrial			1		1	2				
Waste		1.5			0.5	1.5	0.5			
Water		1	5		1	6	1			
Agriculture					1	2				
Energy	3				2	2	3			
Fishery	2		1			3				
Transport	2				1	2	1			
Total	7	8.5	10	3	7.5	22.5	14.5			

The indicators in the core set were selected from a much larger set on the basis of nine criteria[30] widely used elsewhere in Europe and by the OECD with particular attention being paid to relevance to policy priorities, objectives and targets; the availability of high-quality data over both time and space, and the application of well-founded methods for indicator calculation (EEA, 2005).

Many of the indicators in the EEA core set are also used in indicator processes being implemented elsewhere, notably at the European Commission, OECD, and WHO (EEA, 2005).

References

EEA, 2012.Environmental Indicator Report. Ecosystem Resilience and Resource Efficiency in a Green Economy in Europe. Luxembourg: Publications Office of the European Union, 2012. ISBN 978-92-9213-315-3 doi:10.2800/4874

EEA, 2005. EEA core set of indicators Guide. EEA Technical report No 1/2005 - ISSN 1725-2237. Pp 38.

[30] The criteria comprise: i) policy relevance, ii) progress towards targets, iii) available and routinely collected data, iv and v) spatial and temporal coverage, vi) national coverage and representativeness of data, vii) understandability of indicators, viii) methodology well founded and ix) EU priority policy issues.

Alternative approaches

5.15 The overall results show that indicators of 'State', for example, 'conductivity', 'pH', 'salinity', 'temperature', 'Chl *a*', 'fish biomass' and 'abundance of dietary functional groups', 'sea ice extent', 'sea surface temperature', in the 'Living and Non-living Resources', 'Water Quality and Contaminants' and 'Physical Parameters' categories are the most prevalent However, in the 'Drivers, Pressures and Stresses' and 'Management and Response' categories 'Pressure' and 'Response' indicators prevail respectively. Examples of 'Pressure' indicators include 'illegal fisheries', 'illegal discharges of oil at sea', 'tourism'. It is often problematic to assign an indicator to a specific category. For example, the TWAP indicator 'bycatch/discards' could be viewed purely as an indicator of 'Pressure' but could also be viewed as an indicator of 'State'.

5.16 Another approach to assessing the marine environment is causal chain analysis (CCA) (GIWA, Case Study 7). This approach provides a descriptive, qualitative method to identify priorities for remedial and mitigatory actions. While addressing similar issues there is no common terminology.

Case Study 7: Global International Waters Assessment (GIWA) Causal Chain Analysis

GIWA is a global initiative covering 66 trans-boundary marine and freshwater areas. The overall objective of GIWA is to develop a comprehensive strategic assessment that may be used by GEF and its partners to identify priorities for remedial and mitigatory actions in international/transboundary water bodies. The objective is to produce a comprehensive and integrated global assessment of international waters encompassing the ecological status of and causes of environmental problems of transboundary freshwater basins and their associated coastal and ocean systems.

GIWA focuses on five major problems and 23 specific environmental and socio-economic problems (Table 1).

Table 1. GIWA five major problem areas and 23 specific environmental and socio-economic problems [31]

1. Freshwater shortage	2. Pollution	3. Habitat and community modification	4. Unsustainable exploitation of fisheries and other living resources	5. Global change
Reduction in stream flow	Microbiological pollution	Loss of ecosystems or ecotones	Inappropriate harvesting practices	Changes in hydrological cycles
Pollution of existing water supplies	Eutrophication	Modification of ecosystems or ecotones including community structure and/or species	Resource/habitat changes	Sea level change

[31] http://www.unep.org/dewa/giwa/giwafact/giwa_in_brief.asp

		composition		
Lowering of the water table	Chemical pollution		Habitat destruction	Increased UV-B radiation as a result of ozone depletion
	Suspended solids		Decreased viability of stock through contamination and disease	Changes in ocean carbon dioxide source/sink function
	Solid wastes		Man-induced changes in the physical environment	
	Thermal pollution		Biodiversity impacts	
	Radionuclides			
	Spills			

GIWA addresses these problems using Causal Chain Analyses (CCA). CCA traces the cause-effect pathways from the socio-economic and environmental impacts back to their root causes (Figure 1). The GIWA CCA aims to identify the most important causes of each concern prioritised during a scoping assessment in order to direct policy measures at the most appropriate target to prevent further degradation of the regional aquatic environment (Borysova *et al.*, 2005). The analysis is conducted by identifying the human activities that cause the problem and then the factors that determine the ways in which these activities are undertaken. Root causes are, however, frequently difficult to identify often being spatially and temporally distant from the problems they cause. As there is no universal theory describing how root causes interact to create problems in natural resource management and due to the wide variation of local circumstances under which the GIWA methodology is applied, the GIWA CCA is not a rigidly structured assessment with a set of detailed instructions, but rather a framework to guide the analysis (Borysova *et al.*, 2005).

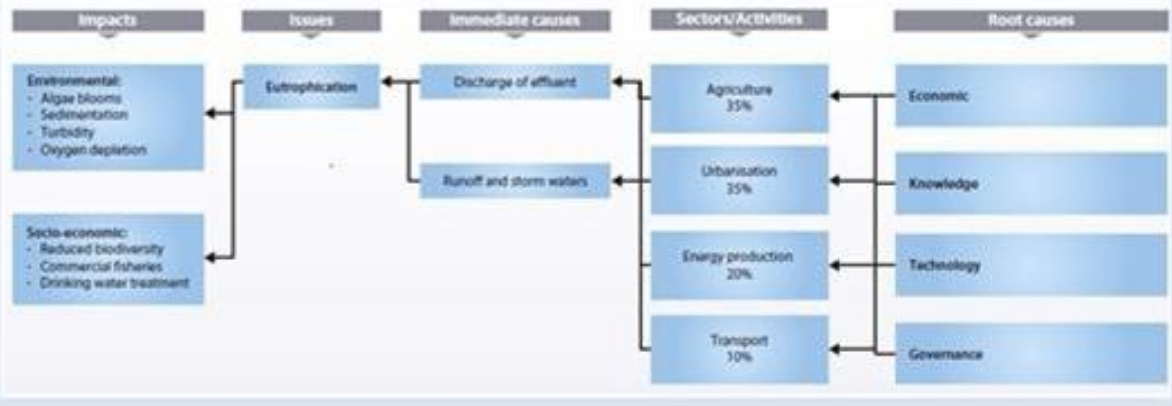

Figure 1. Flow Chart Diagram of the CCA for the Black Sea region (from Borysova *et al.*, 2005)

References:

Borysova, O., Kondakov, A., Paleari, S., Rautalahti-Miettinen, E., Stolberg, F. and D. Daler, 2005. Eutrophication in the Black Sea region; Impact assessment and Causal chain analysis. University of Kalmar, Kalmar, Sweden.

Constraints

5.17 Many entities cited constraints when selecting and using indicators. Principal amongst these were financial constraints, followed by availability of data, technical, political, governance and cultural constraints (CEP, Case Study 8).

Case Study 8: The Caribbean Environment Programme - constraints and limitations[32]

Background

The Caribbean Environment Programme (CEP) is a UNEP administered Regional Seas Programmes. The CEP is managed by and for the countries of the Wider Caribbean Region through the Caribbean Action Plan (1981), which outlines regional environmental challenges. The Action Plan led to the adoption, in 1983, of the Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region, known as the Cartagena Convention. The Convention provides a legal framework for cooperative regional and national actions within the region. The programmatic framework for the Cartagena Convention is provided by the CEP.

The Convention is supplemented by three protocols: i) Protocol Concerning Co-operation in Combating Oil Spills in the Wider Caribbean Region; ii) Protocol Concerning Specially Protected Areas and Wildlife (SPAW) in the Wider Caribbean Region and iii) Protocol Concerning Pollution from Land-Based Sources and Activities (LBS Protocol).

Constraints

The principle constraint experienced by CEP in its selection and use of indicators is financial. Many countries identified difficulties in establishing and maintaining environmental monitoring programmes due to the high costs associated with such programmes. Many previous programmes in the region have been project-driven and monitoring has ended once the project funds were no longer available.

Another constraint is that, despite some capacity building by the Secretariat and through various projects to selected laboratories in the region, laboratory and institutional capacity remains weak. Countries have identified lack of technical expertise and equipment with which to carry out regular monitoring and analysis.

[32] Based primarily on questionnaire response

A further significant constraint in many countries relates to the lack of a culture to use environmental (ecosystem-based) indicators to inform policy and decision making. The situation is gradually improving. However, issues still remain such as data analysis, lack of national and regional centralized data bases, poor access and availability of data and the lack of transformation of data into information products that can be used for general public awareness and to inform policy/political decisions.

Monitoring and assessment

Currently no comprehensive 'state of the marine environment' reporting is being undertaken by CEP. However, despite the constraints detailed above, the CEP has produced two comprehensive reports to date on pollution loading to the marine environment of the Wider Caribbean[33].

Other monitoring and assessment activities have also been undertaken. Under various large regional projects, marine hot spot assessments, coastal and marine monitoring programmes for specific pollutants, and other monitoring and assessments of coastal and marine ecosystems have been done at the local/national/subregional/regional level. However, these have been project-specific and often in support of already existing national programmes (e.g. status of Caribbean coral reefs with ICRI/GCRM, coral bleaching event report, Caribbean Reefs at Risks with WRI, etc.).

The Secretariat has also recently established a standardized reporting template on the Cartagena Convention and its Protocols. Every two years the Contracting Parties are to provide the status of implementation of their obligations under the Convention. The majority of the information required is process in nature relating to policies, institutions and legal frameworks which have been developed and/or enforced at the national level.

With the entry into force in 2010 of the Land Based Sources of Marine Pollution Protocol, the Secretariat has prepared an outline for a State of Convention Area Report (SOCR)[34] that has been approved by the Governments. Over the coming years resources will be mobilized to prepare the first report.

The draft goal of the outline framework for the SOCR is to develop a standardized reporting format that would aid contracting parties/countries to report on the State of the Convention Area and assist in the development of a regional report on the State of the Convention Area as required under Article XII of the LBS Protocol.

The draft objectives of the outline framework are:

- To provide guidance on reporting information for measures adopted, results obtained and difficulties experienced in the implementation of the LBS Protocol.

[33] Domestic and Industrial Pollutant Loads and Watershed Inflows in the Wider Caribbean Region (2012) (CEP Technical Report 52 - Updated Technical Report 33) and Regional Overview of Land-Based Sources of Pollution in the Wider Caribbean Region (1994) (CEP Technical Report No. 33). Available at: http://www.cep.unep.org/publications-and-resources/technical-reports/technical-reports

[34] http://www.carrcu.org/meetings-events/meeting_info/4

- To provide guidance on reporting for the State of Convention Area so that the scope and format for presenting the information is standardized.

- To use the data and information contained in national reports to prepare regional reports on the implementation of the LBS Protocol and the State of the Convention Area.

- To advise on programmes in place to conduct assessments relevant to the LBS Protocol and to compile and make available to the Contracting Parties reports and studies which may be required or useful for the implementation of the LBS Protocol.

The selection of the proposed SOCR Indicators is based on those used in previous studies by the Secretariat. Sources include i) the Development of UNEP CEP Technical Report 33 on Pollutant Loading to the Caribbean Sea (UNEP, 1994) and the updated CEP Technical Report 52 (UNEP-UCR/CEP, 2010); ii) GEF Integrating Watersheds and Coastal Area Management Project (IWCAM) and its work on Indicators (iii) technical workshops related to existing monitoring capacity in the Wider Caribbean Region aimed at identifying indicators that could be monitored in the region; iv) one indicator that responded directly to the obligations of the Cartagena Convention - process indicators - which are captured in the Cartagena Convention Reporting Template.

References

UNEP-UCR/CEP, 2010. CEP TR No. 52: "Updated CEP Technical Report No. 33 Land-based Sources and Activities in the Wider Caribbean Region".

UNEP, 1994. : Regional Overview of Land-Based Sources of Pollution in the Wider Caribbean Region. CEP Technical Report No. 33. UNEP Caribbean Environment Programme, Kingston, 1994.

Summary

5.18 The current use of marine ecosystem-based indicators and indices by regional entities is both overwhelming in terms of numbers being used and disparate in terms of the different indicators, systems and terminology employed. When trying to compare regions, rather than clarifying, this complexity clouds and confuses any underlying messages that may emerge.

6. Critical evaluation: a proposed way forward for the Regional Seas Programme (RSP)

6.1 This chapter sets out a series of arguments in favour of Regional Seas Conventions and Action Plans recognising a collective set of ecosystem-based global pressures and management responses that entail the collection of regionally specific information contributing to global commitments. The intention is to build upon what is in place whilst also making reference to work on developing sustainable development measures and, as far as possible, taking into account future commitments that regional entities will be required to deliver and/or contribute to. In this context suggestions are advanced concerning identification of suitable specific indicators to provide a reference point likely to support global and regional targets.

The need to build upon existing efforts

6.2 As an individual entity each RSCAP is responsible to its own Contracting Parties. Thus, whilst all regions reflect a similar overall vision, it is understandable that regional specificities and collective targets of the States concerned are reflected in the ecosystem-based indicator systems that have developed. In addition to tailoring to suit particular regional challenges, different regions have varying capacities and are at varying stages of development in terms of data collection, monitoring and assessment to implement the ecosystem approach. This explains the considerable variation in range and detail of the indicators and indices currently in place.

6.3 For several individual RSCAPs development of ecosystem-based indicator systems has involved intensive processes of consultation with appropriate stakeholders (Parties, partners, technical experts). Examples can be found in the Case Studies set out in Chapter 5 of this report, such as CEP's initiative to introduce a standardized reporting template on the Cartagena Convention and its Protocols. Within Europe the EU Marine Strategy Framework Directive has served to further harmonise effort. For example, in addition to those entities highlighted earlier in this report, the UNEP/MAP Barcelona Convention has since 2008 made a concerted effort to articulate a Mediterranean Ecosystem Approach (EcAp) comprising a set of 11 ecological objectives (see below), 28 operational objectives and 61 indicators.

UNEP/MAP Ecological Objectives (EOs)	
1	Biological diversity is maintained or enhanced. The quality and occurrence of coastal and marine habitats and the distribution and abundance of coastal and marine species are in line with prevailing physiographic, hydrographic, geographic, and climatic conditions
2	Non-indigenous species introduced by human activities are at levels that do not adversely alter the ecosystem
3	Populations of selected commercially exploited fish and shellfish are within biologically safe limits, exhibiting a population age and size distribution that is indicative of a healthy stock
4	Alterations to components of marine food webs caused by resource extraction or human-induced environmental changes do not have a long-term adverse effects on food web dynamics and related viability
5	Human-induced eutrophication is prevented, especially adverse threats thereof, such as losses in biodiversity, ecosystem degradation, harmful algal blooms, and oxygen deficiency in bottom waters

6	Sea-floor integrity is maintained, especially in priority benthic habitats
7	Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems
8	The natural dynamics of coastal areas are maintained and coastal ecosystems and landscapes are preserved
9	Contaminants cause no significant impact on coastal and marine ecosystems and human health
10	Marine and coastal litter does not adversely affect coastal and marine environments
11	Noise from human activities causes no significant impact on marine and coastal ecosystems

Table 6.1: UNEP/MAP Ecological Objectives (EOs)

6.4 These are included here as they largely mirror the EU Marine Strategy Framework Directive Good Environmental Status Descriptors. This pan-regional obligation has informed scientific justification discussions on targets, scale, reference versus background conditions and target / indicator priorities. To illustrate this, the operational objectives and indicators adopted by the UNEP/MAP Contracting Parties for EO7 are presented in the table below. The table is extracted from the Decision 20/4 of the 17th Barcelona Convention Contracting Parties Meeting in Paris in 2012[35].

EO7: Alteration of hydrographic conditions does not adversely affect coastal and marine ecosystems	
Operational objectives	***Indicators***
7.1 Impacts to the marine and coastal ecosystem induced by climate variability and/or climate change are minimized	7.1.1 Large scale changes in circulation patterns, temperature, pH, and salinity distribution
	7.1.2 Long-term changes in sea level
7.2 Alterations due to permanent constructions on the coast and watersheds, marine installations and seafloor anchored structures are minimized	7.2.1 Impact on the circulation caused by the presence of structures
	7.2.2 Location and extent of the habitats impacted directly by the alterations and/or the circulation changes induced by them: footprints of impacting structures
	7.2.3 Trends in sediment delivery, especially in major deltaic systems
	7.2.4 Extent of area affected by coastal erosion due to sediment supply alterations
7.3 Impacts of alterations due to changes in freshwater flow from watersheds, seawater inundation and coastal freatic intrusion, brine input from desalination plants and seawater intake and outlet are minimized	7.3.1 Trends in freshwater/seawater volume delivered to saltmarshes, lagoons, estuaries and deltas; desalination brines in the coastal zone
	7.3.2 Location and extent of the habitats impacted by changes in the circulation and the salinity induced by

[35] Further information on how this work is being taken forward on a project basis can be found at: http://enpi-seis.ew.eea.europa.eu/project-activities/data-and-indicators

	the alterations
	7.3.3 Changes in key species distribution due to the effects of seawater intake and outlet

Table 6.2: UNEP/MAP Operational Objectives and Indicators for EO7

6.5 It is not the intention of this study to undermine regional efforts in place and underway, rather to complement them by proposing a coordinated set of parameters based on the understanding that from a global perspective:

a. Previous chapters have revealed a piecemeal mix of regional indicators;
b. The RSP may learn from the LME experience, where different entities have developed their metrics from a common SAP/TDA starting point;
c. Guidance may be useful for those RSCAPs who have yet to establish indicator systems;
d. Some entities (e.g. Abidjan Convention) are at a stage where a collective discussion and justification for a 'coordinated set' of indicators would potentially help negotiations with Contracting Parties; and
e. Other entities are in the process of considering updating their Action Plans and/or transforming their State of the Environment Report activities to deliver a more quantitative Quality Status Report.

Combining with RSP obligations

6.6 Any such 'coordinated set' of indicators should be consistent with obligations in place for the RSP. As explained in Chapter 2, not all RSCAPs are administered by UNEP. However, since 1998 UNEP have convened Global Meetings of the RSCAP Secretariats and the RSP has participated in both Intergovernmental Reviews (IGR) of the Global Programme of Action for the Protection of the Marine Environment from Land-based Activities (GPA) and the Global Conference on Land - Oceans Connection (GLOC). IGR-3 and the first GLOC both took place in January 2012 in Manila, Philippines.

6.7 The Regional Seas Strategic Directions (2013-2016) adopted at the 14th Global Meeting of the RSCAPs (1 - 3 October 2012) represent a useful (albeit non-binding) unifying banner for the RSP. These Strategic Directions recognize the priorities of Rio+20 as expressed in 'The Future We Want' Outcome Document with its emphasis on sustainable fish stocks, maintaining and restoring marine and coastal habitats, countering alien invasive species, protecting marine biodiversity in areas beyond national jurisdiction and addressing ocean acidification and adverse impacts of climate change. Ocean health, resilience and ecosystem functioning stand out as overarching goals. The Strategic Directions encompass a need to strengthen capacities, coordination and collaboration.

6.8 Within the Strategic Directions is also a commitment to contribute to the Manila Declaration of the GPA. In the Manila Declaration emphasis is placed on the core partnership areas of wastewater, nutrients and marine litter. This focus of the GPA on key pressures for the coastal environment is helpful in that it builds on the development and implementation of agreed Protocols and thematic Strategies on specific problems as adopted over the past 30 years by some individual RSCAPs. Other RSCAPs despite not having, for example, a Land-based Sources and Activities Protocol, support the implementation of the GPA through regional projects targeting one or more of the original GPA pollutant source categories (sewage, marine litter, nutrients, physical alteration and destruction of habitats, persistent organic pollutants, sediments, radioactive materials, oil and heavy metals).

Feeding into agreed global assessment processes

6.9 The 'coordinated set' of indicators should also pay due regard to agreed global processes of international cooperation.

6.10 The Parties to the Convention of Biodiversity (CBD) at their 10th Conference of the Parties (CBD COP10 2010) agreed that previous biodiversity protection targets were not met. Within a ten-year framework for action by all countries to save biodiversity (Strategic Plan for Biodiversity 2011-2020) the Parties adopted 20 ambitious yet achievable targets, collectively known as the Aichi Targets. The Aichi Targets are grouped into 5 sections (or strategic goals) as summarized below[36].

Strategic Goal A: Address the causes of biodiversity loss	
1	Make people aware about the values of biodiversity
2	Integrated biodiversity values in development & poverty reduction plan
3	Subsidies which are harmful to biodiversity - eliminate them, phase them out or reform them - taking into account national socio-economics
4	Sustainable production and consumption - natural resources within safe ecological limits
Strategic Goal B: Reduce the direct pressure on biodiversity and promote sustainable use	
5	Reduce the rate of natural habitat loss and forest loss by at least 50%, where feasible close to zero reducing degradation and fragmentation
6	Sustainable fisheries
7	Agriculture, aquaculture and forestry undertaken in a sustainable manner
8	Reduce pollution and excessive use of fertilizer
9	Eradicate or control priority invasive alien species
10	Maintain coral reef integrity and functioning by minimising anthropogenic destruction and impacts of climate change and ocean acidification
Strategic Goal C: Safeguard ecosystems, species and genetic diversity	
11	Conserve terrestrial and inland water, coastal and marine areas through equitably managed, ecologically representative and well-connected systems of protected areas
12	Prevent extinction of threatened species
13	Maintain genetic diversity of cultivated plants and farmed and domesticated animals and of wild relatives
Strategic Goal D: Biodiversity benefits and ecosystem services for all	
14	Safeguard ecosystems for women, tribal peoples and the poor
15	Combat desertification and restore degraded ecosystems
16	Operationalise the Nagoya Protocol on genetic resources via national legislation
Strategic Goal E: Enhance implementation through participatory planning, knowledge management and capacity building	

[36] Note the text here is a précis summary. For full text see: www.cbd.int/sp/targets/

17	National biodiversity strategy and action plans - update for participation
18	Integrate the knowledge of tribal communities
19	Scientific and technological knowledge sharing application
20	Financial resources mobilisation

Table 6.3: Summary of CBD Aichi Targets

6.11 The Aichi Targets are inter-related and should be considered as a whole set but Targets 6,8,10,11 and 15 are particularly relevant to marine regions. CBD COP 11 (2012) agreed on a set of indicators to be used as a mid-term review of progress towards the Aichi Targets (CBD, 2012 Decision XI/3). The indicators developed and brought together by the Biodiversity Indicators Partnership are the primary mechanism for monitoring progress towards the Strategic Plan (UNEP-WCMC, 2012).

6.12 The Aichi Targets are quite rightly biodiversity driven. The World Ocean Assessment (Regular Process, WOA) anticipated the need for more emphasis on socio-economics and has specifically stated an intention to identify the linkages between human well-being and marine environmental changes, including those resulting from human impacts, such as the effects of climate change foreseen by the Intergovernmental Panel on Climate Change. It is expected that the first WOA will draw mostly on secondary sources, presenting a mainly narrative analysis. Subsequent WOA activities are likely to need to draw on indicator information in order to evaluate changing conditions. Several regional entities are developing human dimension indicators as a contribution to both widening their status reporting outputs but also feeding into the WOA. Any 'coordinated set' of RSP indicators could therefore develop to serve as a WOA support mechanism, aligning itself with this initiative.

6.13 A leading example of a regional entity considering human dimension indicators is the North Pacific Marine Science Organisation (PICES)[37]. A PICES expert workshop (Honolulu 13-15 June 2013) considered a list of candidate human dimension indicators in the context of relevant chapters outlined in the structure of the WOA. The focus was fisheries-related and reflecting topics outlined in Chapter 15 of the WOA structure. The workshop considered the need for a narrative to set out context for understanding values reported in different categories; the need to identify drivers of change in socio- ecological systems; and data availability. A summary of the workshop results is reproduced in Table 6.4 below.

[37] PICES comprises a membership of six States (Canada, China, Korea, Japan, United States and Russian Federation) and includes NOWPAP as the appropriate Regional Seas Partnership partner (http://www.pices.int)

Variable	Canada	China	Japan	Korea	Russia	USA	Synoptic	tier
Landings and catch (amount): inside/outside EEZ; seaweeds, fish, shellfish and other invertebrates	X	X	X	X	X	x	X	1
Landings and catch (value): inside/outside EEZ; seaweeds, fish, shellfish and other invertebrates	X	X	X	X	X	x		1
Marine aquaculture production (value and amount): seaweeds, fish, shellfish and other invertebrates	x	x	X	x	x	x		1
Exvessel price					X	x	X	2
Sport fishing (number of anglers, estimated total catch)						x	X	3
Other non-commercial fishing (number of fishers, estimated total catch)						x		3
Fishing costs (amount or percentage of revenues)							X	3
Fishing subsidies (amount)							X	3
IUU fishing (amount)				X		x		1
Fishing vessels (numbers) by gear type, size and tonnage	x	X		X	X	x		1
Fishing vessel power (HP) by gear type, size and tonnage	?	X	X	X	X	x		1
Fishing companies (number)								3
Fishing effort (by gear type)	x	?	?	?		?	X	3
CPUE (by gear type)				X		x		2
Commercial fishers (numbers)	X	x	X	X	x	?/x	X	1
Commercial fishers (characteristics), e.g., average age, percentage full time vs. part time)						?		3
Mortality/injury rates (absolute and relative to national averages)	?	x	X	x	?	x		1

Income of fishermen (absolute and relative to median regional income)	X	x	X	X	x	x		1
~~net revenues from fishing~~	~~X~~	~~?~~	~~?~~	~~X~~	-	~~x~~	-	~~3~~
Fish processing plants (number by scale and scope)	x	X	X	x	x	x		1
Employment in fish processing (numbers; full time and part time)	x		X	?	?			3
Processed fish products (amounts by major category, e.g., fillet, roe, surimi, mince, fishmeal)	?	X	X	X	X	x		3
First wholesale value (value of processed products sold)	?		X	?		x		3
Wholesale markets (number)	?	x	X	x				3
Value added								3
Value added multiplier							X	1
Fishing households (number)	?	x	X	x		?		1
Fishing villages/communities (number)	?	X	X	x	x	x		1
Fishing ports (number)	x	X	X	X	x	x		1
~~Gini coefficient--egality?~~	-	-	-	-	-	~~x~~	~~?~~	~~3~~
Health/contamination monitoring (frequency of incidents relative to total production)	?	?	?	?				?
per capita consumption	X	X	X	x	X	x		1
Seafood price to consumers (index relative to food expenditures)			X					3
Seafood exports (national, footnotes for specifics) (amount and value)	x	X	X	x	X	x		1
Seafood imports (national, footnotes for specifics) (amount and value)	x	X	X	x	X	x		1
Seafood inventories (amount and value)			X					?
Laws and Regulatory structure	?	X	X	X		x		3

International agreements	?	X	?	X		x		3
Value of ecosystem services								3
environmental acct/natural capital								3
valuation of non-marketed goods/services								3
replacement cost of ecosystem services		X						3
Ecocertification/mkt access								3
includes climate induced changes in services								3

Table 6.4: PICES workshop results. X = data presented in slides at meeting; ? = data likely available but not at meeting; x = data sources made available but not presented at meeting

6.14 A comprehensive picture of the world's well-being has also been undertaken by the most recent Global Environment Outlook (GEO-5) (UNEP, 2012a). The companion report 'Measuring Progress: Environmental Goals and Gaps' (UNEP 2012b) reviews and illustrates the world's progress towards meeting international environmental goals for a set of critical issues and highlights gaps in our ability to measure progress, including the absence of clear numerical targets and important gaps in many issues.

Anticipating interface with a possible Sustainable Development Goal on Oceans

6.15 Chapter 2 of this report also highlights another of the main outcomes of the Rio+20 Conference, namely the agreement by UN member States to launch a process to develop Sustainable Development Goals (SDGs). Ten preconditions agreed at Rio+20 are set out in Table 5 and it was further agreed that SDGs should be action-oriented, concise, easy to communicate, limited in number, aspirational, global in nature and universally applicable to all countries while taking into account different national realities, capacities and levels of development and respecting national policies and priorities.

1. Be based on Agenda 21 and the Johannesburg Plan of Implementation
2. Fully respect all the Rio Principles
3. Be consistent with international law
4. Build upon commitments already made
5. Contribute to the full implementation of the outcomes of all major summits in the economic, social and environmental fields
6. Focus on priority areas for the achievement of sustainable development, being guided by the outcome document
7. Address and incorporate in a balanced way all three dimensions of sustainable development and their inter-linkages
8. Be coherent with and integrated into the United Nations development agenda beyond 2015

9. Not divert focus or effort from the achievement of the Millennium Development Goals[38]
10. Include active involvement of all relevant stakeholders, as appropriate, in the process

Table 6.5: Preconditions for SDGs agreed by member States at Rio+20

6.16 The United Nations Conference on Sustainable Development (UNCSD) (2012b) summarized ideas on SDGs and indicators in the run up to Rio+20. Suggestions of focus areas for priority attention at Rio+20 as articulated by member States and major groups in the PrepComs, a proposal by the Governments of Colombia and Guatemala and world Civil Society Organisations respectively included management of the oceans, fisheries and other marine resources; oceans; and healthy seas and oceans as one of their suggested SDGs. The importance of oceans in the discussions on SDGs has subsequently prompted specific proposals building on the momentum of the Rio+20 Conference. A number of countries and organisations have put forward suggestions for integrating oceans into the SDGs, in the form of an oceans' SDG or including oceans in various cross-cutting SDGs. Considerations include the principle that nations should benefit from the resources in their EEZs and focus on priorities within a timeframe from 2015 - 2030 (converging with the post 2015 development agenda). Any SDG should be both attainable and aspirational. A UN Inter-government Open Working Group on SDGs will progressively work on proposals to develop SDGs in a unifying manner that is multilateral with detailed targets.

6.17 This debate on elements for the development of SDGs has prompted further consideration of a structure that allows targets and corresponding indicators to contribute to the achievement of the goals (CBD, 2013). Contrasting approaches are recognized which either:

a. focus each goal on one dimension of sustainable development and underpin this with different specific targets of the same dimension; or
b. envisage targets under broader development goals integrating the three dimensions of sustainable development.

6.18 Different types of goals are also recognized. CBD (2013b, p20) suggest that 'goals such as "healthy and productive ecosystems" would, in effect be biodiversity-related goals [or indeed ecosystem-based], with supporting targets and indicators [for which] all of the Aichi Targets, especially targets 5 to 15 and in particular Target 14 are relevant'.

6.19 This is further reflected in a 'Dashboard Proposal' by Columbia and Guatemala (OWG, 2013) that outlines a basic architecture to differentiate between global goals (focusing on global development priorities) with a core set of targets and indicators for each goal tailored to national priorities and circumstances. In this model each country determines its baseline, milestones, speed and which indicators are relevant and can adjust these to national circumstances

6.20 On 21 March 2013 the Palau Mission to the United Nations promulgated a proposed Oceans SDG as a basis for discussion and an exchange of ideas. The proposal for a Goal to achieve healthy, productive and resilient oceans, recalls ocean-related political texts and emphasizes the importance of ocean health, productivity and resilience for Small Island Developing States (SIDS) as well as making a link with capacity building needs. The proposal includes targets, sub-targets and associated indicators with associated financial and/or technical considerations. A summary is presented in the

[38] The MDGs adopted in 2000, focusing on ending extreme poverty, hunger and preventable disease, will conclude in 2015

box below and a full text is available on-line (Permanent Mission of the Republic of Palau to the United Nations, 2013).

Box 1: Ocean SDG proposal by Permanent Mission of the Republic of Palau to the United Nations	
~~**Target**~~	**Measurement/indicator**
I. Target: Ensure that all fish stocks are being fished sustainably [by target date]	
A. *Maintain or restore* fish stocks to levels that can produce optimum sustainable yield ("OSY") [1]	Tonnage of fish landed in the absence or in excess of OSY as determined by science-based management plans [2]
B. *Eliminate* illegal, unreported and unregulated ("IUU") finishing	Amount (in USD) of IUU fishing [2]
C. *Eliminate* fishing subsidies where they contribute to overcapacity, IUU and destructive fishing	Amount (in USD) of subsidies that contribute to overcapacity, IUU and destructive fishing
II. Target: Ensure a healthy marine environment	
A. *Protect* vulnerable marine area, including coral reefs	Percentage of vulnerable marine areas protected by MPAs within a state's marine territory
B. *Adapt* to ocean acidification	Strategies to account for and adapt to the effects of ocean acidification
C. *Eliminate* marine pollution	A composite of biological and chemical pollutants discharged. This indicator would first require standardised metrics comprised of key sources of marine pollution.
D. *Eliminate* destructive fishing	Vulnerable or unregulated area (in sq. km) subjected to destructive fishing practices [2]

[1] OSY is the management threshold most consistent with the ecosystem approach. It is calculated by modifying Maximum Sustainable Yield (MSY) to account for relevant economic, social or ecological factors. See Cochrane, K. and S.M. Garcia (Eds) A fishery Managers' Guidebook (2nd ed.), FAO and Wiley-Blackwell, 489 (2009).

[2] At each level of state responsibility, to include coastal, port, flag and chartering states, and states of nationality of the beneficial owners.

6.21 It is not the remit of this study to prejudge the SDG negotiations, however, the Plan Bleu Regional Activity Centre of the Mediterranean Action Plan Mediterranean Strategy for Sustainable Development (MSSD) has been working with 34 priority indicators to monitor progress made by Mediterranean countries towards sustainable development in the context of objectives defined for 9 priority issues. Within this established scheme, 4 indicators relate to the objective of 'promoting sustainable management of the sea and coastal areas and take urgent action to put an end to degradation of coastal zones', although other objectives include climate change, cooperation and

human development. In the absence of a composite indicator for sustainable development, the MSSD uses a combination of the Human Development Index and Ecological Footprint of each State to differentiate between high and middle income groups of countries. Preliminary results of the 3rd version (UNEP MAP, 2011) of monitoring outcomes only include one coastal indicator fact sheet assessing wastewater (i.e. land-based sources pollution from coastal cities as measured by numbers of coastal cities with and without wastewater treatment plants).

Regional Seas Marine Biodiversity Assessment and Outlook Series

6.22 In 2010 a rapid assessment measuring the performance of each RSCAP region against a set of common RSP indicators was undertaken as an input to CBD COP10. Indicators selected were based on the DPSIR model with three main drivers: pollution, fishing and climate change as identified in the Millennium Ecosystem Assessment Report (2005) as well as indicators linked to non-indigenous/invasive species and habitat loss.

6.23 This was a first systematic overview at a sub-global scale of the state of knowledge of marine biodiversity in the context of the pressures it currently faces and the management frameworks in place for addressing those pressures. Indicators for outlooks for marine biodiversity in the face of climate change and other continuing and growing pressures from expected increases in human uses and impacts were also considered. Even for this limited set of indicators (22) there were major differences in data availability, analytical protocols and approaches between the different regions. Where possible the exercise drew upon country data (providing a more responsive and detailed perspective) but this was augmented by regional breakdowns of global datasets particularly for the outlook sections. These included the Marine Trophic Index (MTI), species index and invasive species indicators developed by the Sea Around Us Project (www.seaaroundus.org) and the acidification indicator (Aragonite saturation) was based on work by NOAA. Emphasis was placed on scientifically robust, peer reviewed facts and figures. The intention was that this collection of assessments should serve as a baseline for future assessments.

6.24 A parallel can be drawn with the EU 2010 Biodiversity Baseline (EEA, 2010) that also sought to establish a baseline, recognising the complexity of ecosystems means that their status cannot be expressed with a single measure or indicator. In this analysis, an emphasis was placed on favourable or unfavourable status with a distinction between coastal and marine ecosystems and useful supporting information on percentage change over time as illustrated below.

EU 2010 Biodiversity Baseline			
Coastal Ecosystems			
Conservation status	Favourable	Unfavourable	Unknown
Habitat types	8%	70%	22%
Species	11%	56%	33%
□ Artificial areas - increase of surface in the coastal zone: +8% (1990-2000) □ Percentage of threatened coastal species from Nature Directives (amphibians none, reptiles 16%, mammals 20%, birds 12%) □ Change in surface (1990-2006): a. dunes, saltmarshes, salines: -34 km2 (-0.6%) b. intertidal flats, lagoons, estuaries: +43 km2 (+0.3%)			
Marine ecosystem			
Conservation status	Favourable	Unfavourable	Unknown

Habitat types	10%	50%	40%
Species	2%	24%	74%

- Percentage of threatened marine species from Nature Directives (marine turtles not assessed at EU-27 level): mammals 15%, birds 12%
- Alien species - total number in marine/estuarine waters: ca. 1400
- Marine Trophic Index: declining in all European seas
- Percentage of stocks overfished (Maximum Sustainable Yield): 88%
- Commercial fish stocks outside safe biological limits: 46%

Table 6.6: EU 2010 Biodiversity Baseline (extract from EEA, 2010 Annex)

Towards a 'coordinated set' of indicators

6.25 In developing a proposal for a 'coordinated set' of indicators for the RSP, the suite of indicators adopted for the 2010 UNEP Regional Sea Marine Biodiversity Assessment & Outlook Series has been taken as a point of departure. In Table 6.7 below, the relationship with key indicators associated with the other initiatives explored in this chapter is also indicated (in bold) with supplementary related indicators added (in italics).

Pressure	State	Response	Outlook
Nutrient loading *Phosphorus loading* *Marine litter* [**GPA, Aichi Target 8**]	*Extent of dead zones*	GPA (NAPs, LBS) *Proportion of the coastal urban population connected to a sanitation network* [**MSSD Plan Bleu**]	Nitrogen deposition
Port activity	*Total numbers of alien species*	Ballast Water Convention	Species invasions
Climate change (sea surface temperature; CO2 flux) [**Aichi Target 15**]	Aragonite saturation	National Climate Change adaptation	Aragonite
Fish landings *Aquaculture* [**PICES human dimensions**]	FAO stock status Marine trophic index	Fish stocks agreement *Harvested fish within safe ecological limits* [**Aichi Target 6**]	Potential fisheries MTIs Species invasion Local species extinction *Fisher income* *Seafood exports/imports* [**PICES human dimensions**]
Share of artificialized coastline	Red list Index [**Aichi Target 6**]	Marine Protected Areas *Fishery closures*	*Coverage of equitably managed and*

[**MSSD Plan Bleu**]	Trends in critical habitat (coral reef, mangrove, other coastal vegetation) [**Aichi Target 10**]	[**Aichi Target 6, 11; MSSD Plan Bleu**]	*ecologically coherent networks* [**Aichi Target 11**]

Table 6.7: UNEP 2010 Marine Biodiversity Assessment & Outlook Indicators

6.26 A logical next step is to map the review of existing RSP indicators and indices (Chapter 5) against this basic framework to ascertain the level of commonality with what is currently being measured. As highlighted previously, several of the RSCAPs already set ecosystem-based objectives and/or targets, particularly those under the SAPs developed in the framework of GEF-funded projects (e.g. SAP-Med and SAP-Bio within MAP and South China sea as part of the East Asia programme). It seems logical therefore to include the other LME Projects reviewed here, not least as several LMEs have evolved into, or are considering forming, independent Commissions. Furthermore the suite of indicators in Table 7 already incorporates the four TWAP Open Ocean themes, although it is perhaps under-representative of the socio-economic indicators within the LME current indicator suite (i.e. tourism, resident population pressure, human mortality associated with climate change).

6.27 Table 6.8 extends the information presented in Table 6.7 to include an indication of whether the regional entities considered as part of this research have adopted or are considering using indicators related to the pressures, states, responses or outlooks covered by the 2010 UNEP Regional Seas Marine Biodiversity Assessment & Outlook series. As in Table 6.7 individual entities are indicated (in bold) with supplementary related indicators added (in italics).

Pressure	State	Response	Outlook
Nutrient loading *Phosphorus loading* *Chlorophyll a-related indicators; N/P ratio, primary production* [**GPA; Aichi Target 8**] [**TWAP Open Ocean theme, EEA, OSPAR, SPREP, BSC, ROPME, ASCLME, BoBLME, ATS, CEP, Yellow Sea LME, Guinea Current LME]** *Marine litter* [**PERSGA, OSPAR, BOBLME litter categories, Yellow Sea**	*Eutrophication status* [**OSPAR**] *Extent of dead zones* [**BSC**] *Concentrations of selected hazardous substances in biota + sediments* [**HELCOM coreset; BSC EcoQO, OSPAR, ROPME, Guinea Current LME**]	GPA (NAPs, LBS) [**BSC, HELCOM** status of pollutants] *Proportion of the coastal urban population connected to a sanitation network* [**MSSD Plan Bleu**] [**BoBLME**] *Port waste reception facilities MARPOL adoption* [**TWAP; SPREP**]	Nitrogen deposition [**TWAP**] ***HELCOM** availability of targets* *Value of sustainable financing schemes/leverage* [**BoBLME**]

LME]			
Port activity [**SPREP**] *Shipping density*	*Total numbers of alien species* [**BSC, ROPME**] *Trends in arrivals* [**HELCOM coreset**]	Ballast Water Convention	Species invasions
Climate change (sea surface temperature; CO2 flux) [**Aichi Target 15**] [**SPREP, TWAP, EEA, OSPAR**] *Mortality / losses due to extreme events* [**ROPME, TWAP**]	Aragonite saturation [**EEA, ASCLME, OSPAR**] *Regime shift of species* [**BSC**]	National CC adaptation / region-wide [**BoBLME**] *Incorporation of knowledge into management plans* [**ATS**]	Aragonite
Fish landings / *effort / value / vessel registration* *Aquaculture* *Fisheries employment* *No. of FADS* [**PICES human dimensions**] [**PERSGA, BoBLME, TWAP, ASCLME, Benguela CC, SPREP, EEA, ASCLME**]	FAO stock status (level of exploitation) Marine trophic index [**Black Sea EcoQO, TWAP**]	Fish stocks agreement, assessment, updating *Harvested fish within safe ecological limits* [**Aichi Target 6**] [**Yellow Sea LME; Guinea Current LME; Benguela CC**] *Closed fishing seasons, no-fishing areas, area of buffer zones* [**BSC**] *FAO code of conduct compliance; joint fishing agreements* [**TWAP, Guinea Current LME**] *Certified fisheries* [**Humbolt Current LME**]	Potential fisheries MTIs Species invasion Local species extinction *Fisher income/GDP* *Seafood exports/imports* *IUU fishing reduction* [**PICES human dimensions**]
Share of artificialized coastline [**MSSD Plan Bleu]** **[PERSGA, Humbolt Current LME**]	Red list Index [**Aichi Target 6**] [**CCAMLR VME indicators; HELCOM coreset; Black Sea EcoQO; TWAP Open Ocean theme; Yellow Sea LME; Guinea Current LME; CAFF,**	Marine Protected Areas Fisheries closures [**Aichi Target 6, 11**; **MSSD Plan Bleu**] [**Nairobi, Yellow Sea LME; CAFF**] *ICZM guidelines adopted and enabling*	*Coverage of equitably managed and ecologically coherent MPA networks* [**Aichi Target 11**] [**ATS management targets; Humbolt Current LME**]

	SPREP, EEA, ASCLME, OSPAR, Humbolt Current LME], Trends in critical habitat (coral reef, mangrove, other coastal vegetation) [**Aichi Target 10**] [**PERSGA key habitats, CAFF, BSC, ROPME, TWAP, BoBLME, OSPAR, ATS, PEMSEA**]	*legislation, budget* [**BSC; PEMSEA, Nairobi, CPPS**] *EBSAs described* [**TWAP**] *% critical habitat under protection* [**BoBLME**]	*Seabed mining claims* [**TWAP**]

Table 6.8: Expanded indicator set reflecting existing regional ecosystem-based indicators and indices

6.28 As explained in Chapter 4, the variation in regional indicators and their different detailed specification means this analysis is something of a generalization. However, the balance of existing regional indicators in favour of living and non-living resources and water quality and contaminants is reflected here. Invasive / non-indigenous species is the least populated of the themes and the biodiversity assessment 'outlook' indicators have least commonality with other initiatives and entities. Some regional specifics that can be associated with a theme (e.g. % sea ice cover and climate change) are inappropriate to any generic suite but remain of critical importance to individual regions. Table 6.9 presents an illustrative first draft 'coordinated set' of 22 indicators as a basis for discussion. The intention of this table is to prompt discussion and to provide a possible framework within which sub-indicators can be nested. For example, several RSCAPs evaluate the loading of different heavy metals; critical habitat will vary between different biogeographic provinces; and for NAPs it may be appropriate to consider budget available as a sub-indicator.

RSP Pressure and potential associated indicator	
Total inputs of nitrogen and phosphorus from agriculture, sewage and atmospheric nitrogen	Chlorophyll a concentration as an indicator of phytoplankton biomass
Inputs of marine chemical pollution	Trends for selected priority chemicals (e.g. PCBs)
Overall levels of marine litter	Quantification of beach litter items
Ocean warming Anthropogenic CO2 in the ocean	Annual mean sea surface temperature Carbon dioxide flux (partial pressure of CO2)
Losses due to extreme events	Insurance claims from climate change-related events
Fish landings	Fish catches within EEZs (tonnes) - total capture production
Aquaculture	Application of risk assessment to account for

	pollution and biodiversity impacts
Population pressure / urbanization	% built up coastline
RSP State and potential associated indicator	
Eutrophication status	% problem areas (including occurrence of nuisance phytoplankton and algal toxins)
Pollution hot spots	Status of selected pollutant contamination in biota and sediments and temporal trends
Ocean acidification	Aragonite saturation
Level of exploitation of commercial fisheries	FAO stock status: % stocks overfished compared to MSY
Species replacement as a consequence of capture fisheries	Marine trophic index
Endangered species	Distribution of Red List Index species
Loss of critical habitat	Trends in critical habitat extent and condition
RSP Response and potential associated indicator	
National Action Plans to reduce input from LBS	% National action plans ratified / operational
Waste water treatment facilities	% coastal urban population connected
Incentive to reduce marine litter at source	% port waste reception facilities available
Climate change adaptation	% national adaptation plans in place
Fish harvested within safe ecological limits	Fisheries measures in place (by-catch limits, area-based closures, recovery plans, capacity reduction measures) and multilateral/bilateral fisheries management arrangements
Critical marine habitat under protection	% Marine protected areas designated
ICZM in place	ICZM guidelines and enabling legislation adopted for the region

Table 6.9: Illustrative first draft of a RSP 'Coordinated Indicator' set

6.29 If consensus towards achieving such a 'coordinated set' can be achieved, a cross-check with the structure of the WOA[39] and the balance of different categories highlighting those areas of critical importance[40] (e.g. living and non-living resources, water quality and contaminants, socio-economic factors, and management of global change) to reflect the vision of healthy, productive and resilient seas. Table 6.10 illustrates such a cross-check.

[39] Available online: http://www.un.org/depts/los/global_reporting/Outline_of_the_First_Global_Integrated_Marine_Assessment.pdf [Accessed 4 September 2013]

[40] Using the same philosophy employed by TWAP to group LME indicators except that for 'Living Rources' TWAP have split 'Productivity' and 'Fish and Fisheries' (see Chapter 5, Case Study 5)

RSP Pressure and potential associated indicator		WOA
Total inputs of nitrogen and phosphorus from agriculture, sewage and atmospheric nitrogen	Chlorophyll a concentration as an indicator of phytoplankton biomass	6,20
Inputs of marine chemical pollution	Trends for selected priority chemicals (e.g. PCBs)	20
Overall levels of marine litter	Quantification of beach litter items	25
Ocean warming Anthropogenic CO2 in the ocean	Annual mean sea surface temperature Carbon dioxide flux (partial pressure of CO2)	4
Losses due to extreme events	Insurance claims from climate change-related events	
Fish landings	Fish catches within EEZs (tonnes) - total capture production	11
Aquaculture	Application of risk assessment to account for pollution and biodiversity impacts	12
Population pressure / urbanization	% built up coastline	
RSP State and potential associated indicator		
Eutrophication status	% problem areas (including occurrence of nuisance phytoplankton and algal toxins)	20
Pollution hot spots	Status of selected pollutant contamination in biota and sediments and temporal trends	20
Ocean acidification	Aragonite saturation	5,7
Level of exploitation of commercial fisheries	FAO stock status: % stocks overfished compared to MSY	11
Species replacement as a consequence of capture fisheries	Marine trophic index	11
Endangered species	Distribution of Red List Index species	36-42
Loss of critical habitat	Trends in critical habitat extent and condition	36-42
RSP Response and potential associated indicator		
National Action Plans to reduce input from LBS	% National action plans ratified / operational	20
Waste water treatment facilities	% coastal urban population connected	20
Incentive to reduce marine litter at source	% port waste reception facilities available	18?
Climate change adaptation	% national adaptation plans in place	5
Fish harvested within safe ecological limits	Fisheries measures in place (by-catch limits, area-based closures, recovery plans,	11,15

	capacity reduction measures) and multilateral/bilateral fisheries management arrangements	
Critical marine habitat under protection	% Marine protected areas designated	43?
ICZM in place	ICZM guidelines and enabling legislation adopted for the region	8,26, 27

Legend

- Living and non---living resources
- Water quality and contaminants
- Socio---economic considerations
- Management of global change

Table 6.10: Illustrative first draft of a RSP 'Coordinated Indicator' set cross referenced to WOA structure (chapters) and categories of indicators used to group indicators in this study

Challenges involved in taking this forward

6.30 Prioritising indicator choice should combine scientific rigour with pragmatic considerations such as data availability, appropriate technical expertise (knowledge and resources) and political acceptability. Experience to date is that it is very difficult to persuade Contracting Parties (States) to RSCAPs to agree to any 'core set' of regional indicators. This is likely to be even more problematic at a global level. A decade ago Rice (2003) reviewed indicators used for both communication and decision support arguing then that 'the challenge is not to find an indicator of ecosystem status to use. It is to choose the set that will serve the users' needs best.' (Rice, 2003 p236).

6.31 In particular data availability can be a constraint to building regional indicator sets. A basic premise of developing any coordinated indicator set from those indicators currently being applied by RSCAPs is that baseline data is likely to be available for these parameters. Where data is not available, the decision is whether to invest in monitoring or to use proxy measures and/or draw upon global datasets.

6.32 The balance of indicators is another important factor. Any 'coordinated set' of indicators should contribute to global initiatives but cannot be expected to cover every pressure or aspect. Thus, for the illustrative set of indicators, Table 6.10 shows a reasonable balance between important categories but omissions of topics to be covered by the WOA include fish stock propagation, ocean food other than fish and shellfish, shipping, ports, cables and pipelines, desalinization, offshore energy, offshore mining, marine genetic resources etc. In several cases these aspects are being considered by individual regional entities for whom that parameter is important: some other aspects (e.g. marine genetic resources) have yet to be considered at the regional scale. In some cases, to secure more balanced coverage, it may be appropriate to combine indicators. For example, combinations of the indicators suggested in Table 6.9 are possible such as 'net marine primary production' combining satellite derived Chlorophyll a and sea surface temperatures.

6.33 In support of the RSP it seems logical to determine a set of draft Ecological and Operational Objectives to input to / inform the next revision of Regional Seas Action Plans including joint Actions with a wider range of partners. For example, it is clear from the analysis presented in Table 8 that fisheries indicators are central to any suite. Coordination between the UNEP RSP and FAO/Regional Fisheries Management Organisations would serve to strengthen networking and capacity building. Objectives combining environmental policy (resource use, pollution releases, ecosystem risk); economic policy (resource use, productivity, poverty and equality, investment); and social policy (education, health, status of women) are also fundamental to global marine spatial planning. However, their determination requires involvement of various stakeholders.

6.34 The conclusion of this study is that RSCAPs can contribute effectively to determine trend analysis of time series using key indicators. Where possible it is also logical and cost-effective for regional entities to draw on global data sets - as explained in Chapter 4 more than one entity already draws on UNEP-WCMC World Database on Protected Areas, the Global Ocean Observing System, and IOC-UNESCO (OBIS). UNEP should encourage consistency based on further refining the DPSIR extension, data rich-rapid assessment-type, normative indicator suite outlined in Table 8. In this proposal RSCAPs maintain their specific detailed indicators - e.g. regional Ecological Quality Objectives - but an agreed generic global subset would fit within a predetermined structure. There is a link between state of the environment indicators and management performance indicators. However, the model proposed favours a move toward the production of quality status type report setting out the problem (pressure indicators), status (state indicators) and what is being or has been done together with consideration of management effectiveness (response indicators). To take this analysis forward there is clearly a need for a more technical collective discussion to inform selection, weighting and aggregating of appropriate indicators as well as more detailed consideration of baselines.

Conclusion

6.35 This chapter concludes that the current uptake of ecosystem-based indicators by the RSP is uncoordinated and confused from the point of view of a global overview, although individual regions have their own agendas and in some cases well-developed indicator sets. Furthermore, indicators in themselves are not sufficient to describe or understand progress against a baseline. To contribute to governance efforts, indicators should inform ecological and operational objectives. The RSP should and can input to regular global quality status and any such reports could interface and complement the World Ocean Assessment as well as contributing (and, if appropriate, adapting to) an ocean-related Sustainable Development Goal. The draft set of coordinated indicators set out here has sought to identify commonality between approaches already underway within the RSP. In doing so it provides a draft framework that does not impose extra work for RSCAPs but rather proposes the use of existing indicators that fulfill multiple reporting requirements. At the same time it is acknowledged that too many indicators blur any policy message. What is wanted is a process to underpin a communication tool. In other words, an achievable limited set of ecosystem-based indicators agreed by the RSP and endorsed by UNEP. Choosing appropriate metrics requires further work and the opportunity for a more substantive collective technical discussion.

7. Conclusions and recommendations

Conclusions

7.1 The RSCAPs have developed indicators and indices largely independently of one another, in response to implementing Protocols, describing and quantifying emerging threats and producing State of the Environment Reports. As a consequence, within the RSP as a whole, there is considerable variety in terms of choices of indicator, levels of sophistication of indices and timescales over which trends have been monitored and observed. Variable access to resources needed to gather and coordinate indicator suites has contributed to this continuum. However, within the RSP there is also a wealth of relevant expertise.

7.2 This report concludes that it is both possible and desirable for the RSP to agree a coordinated set of ecosystem-based indicators. Such an initiative would be supported by the UNEP-administered RSCAPs in particular. These entities would appreciate an appropriate limited set of indicators allowing comparisons between regions and contributing to initiatives in-hand (including regional State of Environment reporting).

7.3 Within the RSP it is well understood that good indicators should be scientifically valid, simple to understand by the public and policy makers, sensitive and responsive to change, cost effective and policy relevant. An advantage of adopting a coordinated set of indicators would be the use of such information in making explicit the 'value added' of RSCAPs. A robust demonstration of achievements of the RSP and associated benefits is likely to support future investment. This report has demonstrated that many regional parameters are transboundary and biological indicators are often region specific.

7.4 A coordinated set of indicators must be purpose dependent relating explicitly to 'healthy oceans'. It can also be concluded that high-level key policy drivers, requiring targets, indicators and monitoring strategies are already agreed (e.g. CBD Strategic Plan for Biodiversity). The RSP must be clear that collating such information is therefore already an obligation for Contracting Parties and the results will inform policy intervention, help develop choices and trade offs. The objective of a coordinated indicator set is harmonization of effort rather than adding to reporting burdens. National targets relate to global targets and ecosystem-based indicators link to food, jobs and climate resilience.

7.5 This report concludes that it is possible to achieve a coordinated indicator set by gathering information from monitoring undertaken at the national level but by combining this with the opportunity to use global datasets. Examples of both have been identified in this report. Such indicators are not only quantitative. There is value in qualitative indicators and descriptions. Also the RSP should consider proxy indicators (i.e. indirect measures such as coastal population densities). It will be important for the RSP to achieve baselines (i.e. reference state), noting the temporal variability of some indicators (e.g. for some indicators a rolling 5-year average may be more useful than a single year measurement).

7.6 This initiative provides an opportunity to work with LMEs and capitalise on synergies with the TWAP. The second phase of the TWAP (2013-2015) will gather best available data and information from a large number of institutional partners and data providers. Such a partnership between LMEs and the RSP would help both sets of entities converge thinking on a multiplicity of demands and achieve inter-operability of indicators. In this respect the IWLearn tracker tool is a ready-made facility that can be applied (UNEP Live, 2013)

7.7 Finally, this report concludes that any coordinated set of indicators developed by the RSP, in association with LMEs and other, must align itself to the WOA and an ocean SDG(s). Eventually also this must also prompt regional targets (taking into account and building upon the desired state as defined by national administrations) with the expectation that effective management measures can be implemented to achieve them. In Europe, the EU regulatory framework provides a statutory obligation to meet 'Good Environmental Status', but this is not yet the case in most other parts of the world.

Recommendations

7.8 To take forward this work it is recommended that the RSP should:

1. Draw on the experiences of developing criteria and indicators for forests (and possibly deserts) - see Chapter 2. The indicator set proposed by UNFF is perhaps larger then the marine suite envisaged for the RSP, however, the amount of information requested, facilitated by a questionnaire/template, is not onerous. Pre-filling of data and information centrally has been considered, subject to internal discussion. Interagency group work at the national level has also been encouraged but forests do not have the luxury of regional entities like the RSP;
2. Capitalize on the revision of marine indicators being undertaken by the European Environment Agency (EEA) and expected in 2014. EEA streamlines and maintains the core set of indicators (described in Chapter 5, Case Study 6) and, for the four European Regional Seas, a set of marine indicators is populated by a consortium of agencies using EU Member States data as submitted to ICES/Eionet. EEA is currently reorganizing its core marine indicators, including streamlining of methodologies with the work of the European RSCAPs and requirements of the MSFD (Spiteri, pers.com. 5.11.13);
3. Further utilize experience gained during the 5-year Biodiversity Indicators Project, which amongst other issues tackled the tension between a limited set of indicators and the need for comprehensive coverage of issues, achieving standardization, relying on good science and meta-analysis published in Science, thus enabling anomalies to be resolved;
4. Initiate a technical workshop to take forward the findings of this report, which has used the 2010 UNEP RSP Global Biodiversity Assessment as a point of departure for ecosystem-based indicators. At the same time as discussing a coordinated set (or core set), attention should also be given to a supplementary (optional) set and the RSP could seek opportunistic sampling possibilities in partnership with other sectors (e.g. fisheries and shipping). The workshop should also identify and agree data/information sources for each indicator;
5. Recognize that there are many indicators for state but relatively few for human activity pressure or socio-economic responses. The RSP could collectively agree on activity-specific pressure indicators and where appropriate identify cross-sectoral pressures.
6. Join forces with LME experts and build on the development of indicators within the TWAP and the UN Division of Early Warning and Assessment to avoid duplication and consolidate knowledge;
7. Use this as an opportunity to embrace metrics for ecosystem services. In this respect the Tool-kit for Ecosystem Service Site-based Assessment (TESSA) approach (Peh et al, 2013), whilst conceived for terrestrial applications, could serve as a good rapid assessment starting point;
8. Discuss the practicalities and timeframe of how to implement specific indicators (and/or a sub-set of these), relating actions to existing and proposed Protocols, reporting timescales and resource implications; and
9. Produce a roadmap recognising the need to feed into the timelines of global processes in train, noting that 2015 is a year during which several related initiatives are due to come to fruition, but also anticipating the chance to contribute to the WOA and SDG processes within a subsequent 5 - 10 year timescale.

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9. Annexes

Annex 1: Ecosystem-based Indicators Questionnaire

Name of organization ……

Ecosystem-based Indicator System Questionnaire

1. Is your programme regularly carrying out the state of the marine environment reporting? Such reporting may have different names such as quality status reports, transboundary diagnostic analysis, etc, but mainly trying to establish the status of the marine environment for management and policy responses purpose. If so, in which form is such assessment developed? Please give us a specific reference.
   Answer:

2. Have you devised an indicator system to carry out the state of the marine environment reporting or the process described in item 1 above? If not, are you in the process of doing so? How?
   Answer:

3. What indicators are you using? How did you select them?
   Answer:

4. In your programme, do you have specific programme targets or objectives, which may be included in Regional Seas Action Plans, Strategic Action Programmes, Conventions/Protocols and associated instruments, Ecological Quality Objectives, etc.
   Answer:

5. Are there indicators or indices to monitor the progress in achieving these targets or objectives?
   Answer:

6. Are data/information on indicators collected periodically? How often? Are they included on a specific data/information base? Do they inform a report? If so, what is the report? Is there a URL?
   Answer:

7. Are your indicators working? Can you judge how well indicators are performing against certain targets and objectives or describe the chronological changes in the state of the marine environment? If not, why? Can you amend the indicator? How?
   Answer:

8. Are there constraints on your selection/use of indicators? For example financial, technical, other constraints.
   Answer:

9. Do you have a summary of data collection? Is this available? If so, what is the URL?
   Answer:

10. Is there a database of information collected? Is this available? If so, what is the URL?
    Answer:

11. Do you use global datasets and, if so, which? What for? What does it inform?
    Answer:

12. Please indicate your partners in the development and monitoring of indicators.
    Answer:

Feedback on the structure of the draft template SoME reporting Abidjan Convention

Please add your comments in column

a. Column 'relevance': indicate whether the chapter is relevant for your country ?
b. Provide information whether national datasets are available

General comments about the structure of the template are welcomed.

	Title	Description	Note + comments	Relevance ?	National data available/ex perts/ass essments
I		Summary			
II		Context of the national assessment	*Less relevant*		
III	Assessment of major ecosystem services from the marine environment (other than provisioning services)				
3	Scientific understanding of ecosystem services	Overview of the state of scientific understanding of ecosystem services, including data collection, information management and research needs.	*What is the status of national marine research, marine data and information management, research needs ?*		
Chapter 4 - The oceans' role in the hydrological cycle					
4.a.	The interactions between the seawater and freshwater segments of the hydrological cycle: the rate of turnover and changes in it — freshwater fluxes into the sea and their interaction with it, and of anthropogenic changes in those fluxes (for example, from dam building or increased abstraction) — sea-level changes.		*Estuaries, coastal lagoons etc. How are these being affected by changes in river discharges ? Salinization of groundwater etc.*		
4.b.	Environmental, economic and social implications of ocean warming, sea-level change, including the implications of rises in sea level for security and implications for low-lying countries, and anthropogenic and other changes to freshwater fluxes into the sea.		*Coastal erosion*		
4.c.	Chemical composition of seawater: salinity and nutrient content of the different water bodies — changes in salinity and nutrient content.		*Salinity changes, nutrient changes*		
4.d.	Environmental, economic and social implications of changes in salinity and nutrient content.		*Decline in fisheries due to decrease in productivity*		
4.e.	The oceans' role in heat transportation: ocean warming — the overall influence of the oceans on surface temperature and circulation patterns — oceanic oscillations — El Niño and similar events.		*Large-scale changes and patterns in rain fall*		
4.f.	Environmental, economic and social impacts of changes in ocean temperature and major ocean temp. events.		*Drought, flooding, heat waves*		

Chapter 5 - Sea/air interaction				
5.a.	The role of the seas in regulating atmospheric fluxes and concentration of oxygen and carbon dioxide (oxygen production, carbon dioxide sequestration): role of the oceans and seas as carbon dioxide sinks — issues about maintaining or enhancing that role enhancing that role.	*E.g. "Blue Carbon" ecosystems: mangroves, saltmarshes, seagrasses: status and trends*		
5.b.	Scale and significance of the coal industries	*Coal mining and fossil carbon industry (power plants, steel plants etc.)*		
5.c.	Meteorological phenomena related to the oceans: hurricanes and typhoons — monsoon rains — trade winds	*Occurrence and trends of tropical storm frequency, prevailing winds, etc.*		
5.d.	Environmental, economic and social implications of trends in meteorological phenomena, including changes in the frequency and intensity of storms, effects on seas covered by ice for much of the year and the communities that depend on them, and the implications for small island developing States.	*Storm damage in coastal communities.*		
5.e.	Ocean acidification: degree and extent of ocean acidification resulting from human activities (including coral bleaching).	*Is anything known yet at the national level ? Relevant ?*		
5.f.	Environmental, economic and social implications of trends in ocean acidification (with cross-reference to part IV on assessment of cross-cutting issue: food security and food safety).			
Chapter 6 - Primary production, cycling of nutrients, surface layer and plankton				
6.a.	(Global) distribution of primary production: the reasons for the present distribution — factors affecting cycling of nutrients and the variability and resilience of the base of the food web — changes known and foreseen, including changes in ultraviolet radiation from ozone-layer problems.	*Chl a primary production patterns*		
6.b.	Surface layer and plankton: role of the surface layer — factors influencing it — variations in plankton species.	*Influence of upwelling, planton species etc.*		
6.c.	Environmental, economic and social implications of trends in primary production and other factors affecting the inherent variability and resilience of the base of the food web (with cross-reference to part IV on assessment of cross-cutting issue: food security and food safety).	*Do year to year changes occur in primary productivity and how does this affect fisheries and food security ?*		
Chapter 7 - Ocean-sourced carbonate production				
7	Role of ocean-sourced carbonate production in the formation of atolls and beaches - potential impacts of ocean acidification.	*Are there coral reefs ? how are these likely to be affected by ocean acidification ? R*		

Chapter 8 - Aesthetic, cultural, religious and spiritual ecosystem services derived from the marine environment				
8	Scale of human interactions with the oceans and seas on the aesthetic, cultural, religious and spiritual levels, including burials at sea, and ways in which these interactions may be affected by other changes. There would also be a cross reference to chapter 27 (Tourism and recreation).	*Relevance of oceans and seas for indigeneous groups (e.g. cultural manifestations), tourism etc.*		
Chapter 9 - Conclusions on major ecosystems services other than provisioning services				
9	Summary of the main issues, including capacity-building needs and information gaps, as identified in chapters 3 to 8.			
III	**Assessment of the cross-cutting issues: food security and food safety**			
Chapter 10 - Oceans and seas as sources of food				
10	Scale of human dependence on the oceans and seas for food and pressures of increased demands, and the extent to which some parts of the world depend on other parts for fish and seafood and the contribution of living marine resources to food security.	*Dependence of coastal populations on fish, export of seafood to other regions*		
Chapter 11 - Capture fisheries				
11.a.	Commercial fish and shellfish stocks: present status of fish and shellfish stocks that are commercially exploited and factors affecting them, including fishing practices — scale of economic activity (large-scale commercial, artisanal and recreational fishing).	*What is the status of fish stocks ? FAO data*		
11.b.	Other fish and shellfish stocks: present status of fish and shellfish stocks exploited by artisanal or subsistence fishing — significance for livelihoods — present status of fish stocks not currently exploited.	*Data and information on artisanal and subsistence fishing - is information available ?*		
11.c.	Impacts of capture fisheries (large-scale commercial, artisanal and subsistence fishing) on marine ecosystems, through effects on the food web, bycatch (fish, mammals, reptiles and seabirds), and different fishing gear and methods, including the impact of discards on other wildlife, and impacts from lost or abandoned fishing gear.	*Bycatch: marine turtles, mammals*		
11.d.	Effects of pollution on living marine resources: possible effects of chemical and radioactive pollution on stocks of living marine resources used for food — implications of potential threats of such pollution.	*Does pollution affect marine food resources (e.g. offshore oil and gas, dumping waste in coastal lagoons ? Is data available ?*		
11.e.	Illegal, unreported and unregulated fishing: scale, location and impacts on fish stocks.	*Is data and information available on IUU fisheries along the coast ? Are the local*		

		fisheries being affected ?		
11.d.	Significant environmental, economic and/or social aspects in relation to capture fisheries.			
11.g.	Projections of the status of fish and shellfish stocks over the next decade in the light of all relevant factors.	*What is known about future projections of fish stocks in the region ?*		
11.h.	Identify gaps in capacity to engage in capture fisheries and to assess the environmental, social and economic aspects of capture fisheries and the status and trends of living marine resources.	*What capacity building is needed for fisheries management ?*		
Chapter 12 - Aquaculture				
12.a.	Scale and distribution of aquaculture: locations of aquaculture activities - species cultivated — economic significance and contribution to food security.	*Status and significance of national aquaculture*		
12.b.	Scale and distribution of aquaculture: locations of aquaculture activities — species cultivated — economic significance and contribution to food security.	*Surface in hectare, fish meal input*		
12.c.	Pollution and contamination from aquaculture: use of chemicals — interactions of escaped stock with wild stocks.	*Probably not relevant ?*		
12.d.	Significant environmental, economic and/or social aspects in relation to aquaculture.			
12.e.	Projections of the role of aquaculture over the next decade in the light of all relevant factors.	*Information on how aquaculture is likely to develop in the next decade ?*		
12.f.	Identify gaps in capacity to engage in aquaculture and to assess the environmental, social and economic aspects of aquaculture.	*What capacity is missing to engage in aquaculture ?*		
Chapter 13 - Fish stock propagation				
13.a.	Rebuilding depleted stocks through marine ranching and release of fish from hatcheries.	*Probably not relevant ?*		
13.b.	Transplantation of living marine resources to different ecosystems.	*Escaped fish and other species affecting ecosystems.*		
13.c.	Effects of artificial propagation on natural ecosystems	*Probably not relevant ?*		
13.d.	Significant environmental, economic and/or social aspects in relation to fish stock propagation.	*Probably not relevant ?*		
13.e.	Identify gaps in capacity to engage in fish stock propagation and to assess the environmental, social and economic aspects of fish stock propagation.	*Probably not relevant ?*		
Chapter 14 - Seaweeds and other sea-based food				
14.a.	Scale, location of collection and significance of food derived from the oceans and seas other than fish	*Probably not relevant ?*		

	and shellfish — projected developments over the next decade.			
14.b.	Potential impacts of collection of seaweed and other sea-based food.	*Probably not relevant ?*		
14.c.	Significant environmental, economic and/or social aspects in relation to the collection of seaweeds and other sea-based food.	*Probably not relevant ?*		
14.d.	Identify gaps in capacity to assess the environmental, social and economic aspects of seaweed and other sea-based food.	*Probably not relevant ?*		
Chapter 15 - Social and economic aspects of fisheries and sea-based food				
15.a.	Relationship with human health: health benefits and problems from sea based food, including the potential to supplement protein-poor diets — chemical, toxic and bacterial contamination.	*Importance as protein source, evidence of contamination of fish and implications for human health*		
15.b.	Scale and significance of employment in fisheries and aquaculture: numbers employed — relationship of earnings to local median earnings — scale of injuries to fishers compared to other industries.	*Data on employees in fisheries, injuries, casualties.*		
15.c.	Role of fisheries in social structure: role of fishers in local societies — extent to which fishing is the sole source of livelihood — extent to which local societies are dependent on fisheries and aquaculture.	*What is the social and socio-economic status of communities dependent on fisheries ?*		
15.d.	Relationship between catch areas, ownership and operation of fishing vessels, landing ports and consumption distribution: the benefits which States (and economic operators based in them) obtain from fisheries and aquaculture.	*Foreign vessels fishing in EEZ zones: role, benefits, problems*		
15.e.	Implementation of international fisheries agreements	*Status of international fisheries agreements*		
15.f.	Effects of changes in markets: growth of long-distance transport of landed fish and shellfish.	*Evolution of transport of seafood abroad to new markets and effects*		
15.g.	Links to other industries: scale of economic activity dependent on fisheries and aquaculture, both in providing equipment (especially ships) and in processing output in value chains.	*From fish to fisheries derived products: impact, extense*		
15.e.	Identify gaps in capacity to engage in fisheries and to assess the environmental, social and economic aspects of fisheries.	*Capacity building needs for development of fisheries and fisheries management*		
Chapter 16 - Conclusions on food security				
16.a.	Summary of the main issues, including capacity-building needs and information gaps.			
16.b.	Longer-term development of food from marine resources — impacts of climate change in the context of	*Is data and information*		

	the United Nations Framework Convention on Climate Change and based on the conclusions of the Intergovernmental Panel on Climate Change — impacts of population changes — relation with changes in terrestrial food production.	*available on how the longer-term development of fisheries will develop ?*		
V	**Assessment of other human activities and the marine environment**			
Chapter 17 - Shipping				
17.a.	Significance of shipping: major ports — amount of trade carried by sea - economic benefits from shipping activities, including as flag States - projections of changes over the next decade.	*Basic data and information about shipping, trade and ports*		
17.b.	Threats from shipping: locations, scale and trends — pollution from shipping (the acoustic impact of shipping on marine organisms — shipping disasters, including their longer-term effects — invasive species through ballast water and other biosecurity risks — transport of ships for ship-breaking — risks to coastal States from shipping compared to their trade).			
17.c.	Threats to the marine environment posed by the transport by sea of hazardous and noxious substances and of radioactive substances.	*Extent of transport of waste*		
17.d.	Links to other industries and commerce: ship-building - ship-breaking - bunkers- insurance, chartering and navigation services.	*Probably less relevant ?*		
17.e.	Significant environmental, economic and/or social aspects in relation to shipping.			
17.f.	Identify gaps in capacity to engage in shipping and to assess the environmental, social and economic aspects of shipping, including implementation of international conventions and other instruments.	*What capacity is missing to engage in shipping and environmental aspects of shipping ?*		
Chapter 18 - Ports				
18.a.	Scale and significance of port activities: locations and traffic — projected growth, including the implications of changes in shipping routes considered under issue 17.A — economic benefits to port States.			
18.b.	Impacts of the creation and maintenance of ports: scale of port development — dredging for navigational purposes — management of ships' waste, including effects of charging regimes — pollution from ships in port — remobilization of pollutants by dredging.	*e.g. increased erosion/sedimentation, pollution, oil pollution (e.g. Pointe Noire)*		
18.c.	Significant environmental, economic and/or social aspects in relation to the construction and managent of ports	*Destruction of coastal and marine habitats by port construction*		
18.d.	Identify gaps in capacity to assess the environmental, social and economic aspects of ports and monitoring their impact on the marine environment.	*Capacity needed to assess and monitor environmental, social*		

		and economic impact of ports		
Chapter 19 - Submarine cables and pipelines				
19.a.	Scale, location and role of cables and cable-laying: role in international communications and the Internet — projected developments over the next decade - employment — links to other industries — economic benefits.	*New communication cables and impact on internet access.*		
19.b.	Potential pollution and physical harm from cables and pipelines — during construction/installation — during use — after decommissioning.	*New oil fields and connecting pipelines: construction and effects during construction*		
19.c.	Significant environmental, economic and/or social aspects in relation to pipelines and cables and pipeline and cable-laying.			
19.d.	Identify gaps in capacity to engage in cable-laying and pipeline installation and to assess the environmental, social and economic aspects of cable-laying and pipeline installation.	*Pipelines construction: is this done by local workers ?*		
Chapter 20 - Coastal, riverine and atmospheric inputs from land				
20.a.	Municipal wastewater, including the impact of major cities and of cruise ships in harbours: scale and degree of treatment — nature of impact, both through direct and riverine inputs and including impacts on microbiological quality of coastal waters, as well as economic impacts of adverse effects on water quality, especially on aquaculture and tourism — projected developments over the next decade.	*Impact of municipal wastewater on coastal lagoons, estuaries, etc., impact on tourism*		
20.b.	Industrial discharges, including point sources: hazardous substances, including persistent organic pollutants and heavy metals - hydrocarbons -nutrients- scale of discharges (direct and riverine inputs and atmospheric transport)- degree of treatment- nature of impact, including impacts on human health through food chain - projected developments over the next decade.	*Major industries polluting rivers discharging into the sea, oil pollution etc.*		
20.c.	Agricultural run-off and emissions: scale (direct and riverine inputs and atmospheric transport of nutrients) — nature of impact — projected developments over the next decade.	*Nitrate and phosphates entering rivers: data available ?*		
20.d.	Eutrophication: combined effects of municipal, industrial and agricultural inputs (including algal blooms), considering also the effects of turbidity in coastal waters and denitrification in estuaries — cross-reference to effects on fish stocks and effects on the food web.	*Coastal lagoons affected by eutrophication ?*		
20.e.	Inputs of radioactive substances from both nuclear and non-nuclear industries — actual, potential and suspected impacts of inputs of radioactive substances.	*Probably not relevant ?*		
20.f.	Significant environmental, economic and/or social aspects in relation to managing the impact of land-based inputs.			
20.g.	Identify gaps in capacity to assess the environmental, social and economic aspects related to coastal, riverine and atmospheric inputs from land.	*What capacity is lacking for a better environmental waste management ?*		

20.h.	Scale of desalinization and its environmental impacts. Identify gaps in capacity to engage in desalinization and to assess the environmental, social and economic aspects of desalinization.	*Probably not relevant ?*		
Chapter 21 - Offshore hydrocarbon industries				
21.a.	Scale and significance of the offshore hydrocarbon industries and their social and economic benefits.	*Data and information about scale and significance*		
21.b.	Impacts from exploration, including seismic surveys and exploitation and decommissioning.	*Data and information about impacts, if known.*		
21.c.	Offshore installation disasters and their impacts, including longer-term effects.	*Data and information about impacts, if known.*		
21.d.	Significant environmental, economic and/or social aspects in relation to offshore hydrocarbon installations.			
21.e.	Identify gaps in capacity to engage in offshore hydrocarbon industries and to assess the environmental, social and economic aspects of offshore hydrocarbon industries.	*To what extent are foreign oil producers relying on local staff ? What skills are lacking to assess and manage hydrocarbon industries ?*		
Chapter 22 - Other marine-based energy industries				
22.a.	Scale of wind, wave, ocean thermal and tidal power generation — current, planned and forecast.	*Probably not relevant ? Future evolution ?*		
22.b.	Environmental benefits and impacts of wind, wave, ocean thermal and tidal power generation.			
22.c.	Expected economic performance of wind, wave, ocean thermal and tidal power generation.			
22.d.	Identify gaps in capacity to engage in offshore wind, wave, ocean thermal and tidal power generation and to assess the environmental, social and economic aspects of offshore wind, wave, ocean thermal and tidal power generation.			
Chapter 23 - Offshore mining industries				
23.a.	Scale and significance of sand and gravel extraction: environmental impacts of sand and gravel extraction.	*Beach sand mining and erosion.*		
23.b.	Economic benefits of sand and gravel extraction.			
23.c.	Developments in other seabed mining: current state and potential scale.	*Mineral extraction - developments*		
23.d.	Significant environmental, economic and/or social aspects in relation to offshore mining industries	*Is deepsea mining taking place ? what are the impacts (is anything known)*		

23.a.	Identify gaps in capacity to engage in offshore mining and to assess the environmental, social and economic aspects of offshore mining.	*If any activities are taking place, is local staff involved ? If opportunities exist, what capacity is needed to engage in this.*		
Chapter 24 - Solid waste disposal				
24.a.	Types and amounts of waste dumped at sea, including explosives and hazardous liquids and gases, and potential impacts on the marine environment - projected levels of dumping over the next decade.	*Is waste dumping still taking place ? To what extent ?*		
24.b.	Significant environmental, economic and/or social aspects in relation to solid-waste dumping at sea.	*If solid-waste dumping is taking place, what effects are known ?*		
Chapter 25 - Marine debris				
25.a.	The multiple causes of marine debris, including lack of controls on land-based disposal of waste, lack of management of beach litter and ship-generated litter, and the scale and distribution of the problem.	*Plastic litter on beaches: data and information on the extent of the problem.*		
25.c.	Approaches to combating marine debris — range of application — cases where progress has been made.	*Management of marine debris - is anything taking place ?*		
Chapter 26 - Land/sea physical interaction				
26.a.	Land reclamation: scale and location of land reclamation and habitat modification and the habitats affected — significant environmental, economic and/or social aspects in relation to land reclamation and habitat modification.	*Probably not relevant ?*		
26.b.	Erosion of land by the sea: economic and social costs of land erosion - effects on marine and coastal habitats of coastal defences, including beaches and fringing islands - costs of coastal defences - significant environmental, economic and/or social aspects in relation to erosion of land by the sea.	*Extent of the problem and consequences*		
26.c.	Sedimentation changes: sedimentation in the marine environment as a result of land erosion by rainfall and rivers — decline in marine sedimentation as a result of water management - effect of both types of change on marine and coastal habitats, including estuaries, deltas, submarine canyons — significant environmental, economic and/or social aspects in relation to control of the causes of sedimentation change.	*Probably not relevant ?*		
26.d.	Identify gaps in capacity to assess land/sea physical interaction.	*What gaps exist to assess e.g. coastal erosion ?*		
Chapter 27 - Tourism and recreation				
27.a.	Location and scale of tourism and recreation, including cruise ships: employment — economic benefits of tourism — economic benefits resulting from protecting marine biodiversity.	*Coastal hotels, tourist beaches etc., number of tourists.*		

27.b.	Recreational and sport fishing and its impact on marine wildlife.	*Big game fishing (e.g. Swordfish)*		
27.c.	Impacts of recreational and tourist vessels on sensitive sea areas.	*Probably less relevant ?*		
27.d	Contribution of tourism to problems of sewage and pollution, including from cruise ships	*Probably less relevant ?*		
27.e.	Location and scale of other environmental impacts of tourism, including habitat disturbance and destruction.	*Tourist facilities affecting coastal environment. Probably less relevant compared to other factors (urban development).*		
27.f.	Relationship of tourism to protection of marine species and habitats (for example, whale-watching and whale sanctuaries).	*Probably less relevant, maybe turtle nesting ?*		
27.g.	Significant environmental, economic and/or social aspects in relation to managing the environmental impacts of tourism on the marine environment.			
27.h.	Identify gaps in capacity to assess the interface of tourism and the marine environment and the environmental, social and economic aspects of tourism.	*Capacity building needs ?*		
Chapter 28 - Desalinization				
28.	Scale of desalinization and its social and economic benefits. Identify gaps in capacity to engage in desalinization and to assess the environmental, social and economic aspects of desalinization.	*Probably not relevant in the region ?*		
Chapter 29 - Use of marine genetic resources				
29.a.	Current topics, locations and scale of marine scientific research and exploitation, including the uses being made of marine genetic resources and associated issues such as intellectual property rights and impacts.	*Probably not relevant in the region ?* *Are foreign companies doing research in the region (research on marine species for medicines etc.)*		
29.b.	Significant environmental, economic and/or social aspects of marine scientific research relating to, and exploitation of, marine genetic resources.			
29.c.	Identify gaps in capacity to engage in marine scientific research relating to, and exploitation of, marine genetic resources and to assess the environmental, social and economic aspects of them.			
Chapter 30 - Marine scientific research				
30.a.	Topics, scale and location of marine scientific research.	*National marine research institutions: research topics*		
30.b.	Significant environmental, economic and/or social aspects in relation to marine scientific research.			
30.c.	Identify gaps in capacity to engage in marine scientific research and to assess the environmental, social and economic aspects of marine scientific research, including transfer of technology.	*Capacity building needs in marine research etc.*		

Chapter 31 - Conclusions on other human activities				
31	Summary of the linkages between driving forces related to human activities and the state of the marine environment, having regard to the various types of pressure.			
Chapter 32 - Capacity building				
32	General conclusions on the identification of gaps in capacity to engage in the human activities described above and to assess the environmental, social and economic aspects of human activities affecting the marine environment.	*General conclusion and summary on capacity building needs*		
VI	**Assessment of marine biological diversity and habitats**			
33	Introduction - an overview of national marine biological diversity, to review the status and trends of, and threats to, marine ecosystems, species and habitats that have been scientifically identified as threatened, declining or otherwise in need of special attention or protection; review of the significant environmental, economic and/or social aspects in relation to the conservation of marine species and habitats; and to identify gaps in capacity to identify marine species and habitats that are identified as threatened, declining or otherwise in need of special attention or protection and to assess the environmental, social and economic aspects of the conservation of marine species and habitats.	*General introduction on national marine biodiversity, status and trends on threats to marine environment, environmental, economic, social impacts of conservation, gaps in capacity for management*		
Chapter 34 - Scale of marine biological diversity				
34	Main gradients of diversity for species, communities and habitats (coastal to abyssal, substrate type, salinity).			
Chapter 35 - Extent of assessment of marine biological diversity				
35	Proportion of major groups of species and habitats on a systematic basis for status, trends and threats.			
35.a.	For: Coastal (intertidal and shallow water (<50m)) rock and biogenic habitats (for example, kelp forests and shallow-water, tropical coral (and other biogenic) reefs)	*Description for each of these habitats if data and information is available.*		
35.b.	For: Coastal sediment habitats, including vegetated habitats (for example, mangroves, salt marsh and other macro-vegetation areas and seagrass and eelgrass beds)			
35.c.	Shelf rock (~50-200m) and biogenic reef habitats			
35.d.	Shelf sediment habitats			
35.e.	Deep sea (bathyal and abyssal) habitats (for example, seamounts, deep-sea banks and plateaus, hydrothermal vents and cold-water coral (and other biogenic) reefs)			
35.f.	Water column habitats			
Chapter 36 - Overall status of major groups of species and habitats				

36				
36.a.	For: Coastal (intertidal and shallow water (<50m)) rock and biogenic habitats (for example, kelp forests and shallow-water, tropical coral (and other biogenic) reefs)	*Description for each of these habitats if data and information is available*.		
36.b.	For: Coastal sediment habitats, including vegetated habitats (for example, mangroves, salt marsh and other macro-vegetation areas and seagrass and eelgrass beds)			
36.c.	Shelf rock (~50-200m) and biogenic reef habitats			
36.d.	Shelf sediment habitats			
36.e.	Deep sea (bathyal and abyssal) habitats (for example, seamounts, deep-sea banks and plateaus, hydrothermal vents and cold-water coral (and other biogenic) reefs)			
36.f.	Water column habitats			
Marine ecosystems, species and habitats scientifically identified as threatened, declining or otherwise in need of special attention or protection				
37	Coastal rock and biogenic habitats and related species	Description of the status and trends of each of these habitats.		
38	Coastal sediment habitats and related species			
39	Shelf rock and biogenic reef habitats and related species			
40	Shelf sediment habitats and related species			
41	Deep sea habitats and related species			
42	Water column habitats and related species			
Environmental, economic and/or social aspects of the conservation of marine species and habitats and capacity-building needs				
43	Significant environmental, economic and/or social aspects in relation to the conservation of marine species and habitats			
44	Identification of gaps in capacity to identify marine species and habitats that are identified as threatened, declining or otherwise in need of special attention or protection and to assess the environmental, social and economic aspects of the conservation of marine species and habitats.			
Summary on marine biological diversity				
45	Summary of the main issues, including capacity-building needs and information gaps, identified in chapters 33 to 44.			
46	Overall assessment of human impact on the oceans			
46.a.	Consideration of the implications of cumulative pressures on the overall state of the oceans and seas.			
46.b.	Evaluations under different methods of assessing overall human impact on the oceans and seas.			
47	Overall value of the oceans to humans			