
28 September – 2 October 2015

Paris, France
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Executive summary

The Working Group on Large Marine Ecosystem Programme Best Practices (WGLMEBP) met at UNESCO IOC in Paris for three days in late September, at the same time as the 17th Annual Consultative Meeting on Large Marine Ecosystems and Coastal Partners. WGLMEBP met at 3 sessions over 3 days and was attended by 22 participants.

Work continued on the item of preparing an inventory of Integrated Ecosystem Assessments (IEAs) (agenda item a). Rebecca Shuford (NOAA) gave a presentation on the NOAA IEA program as well as the outcome of an IEA theme session at the 2014 ICES Annual Science Conference (ASC).

On the issue of indicators (agenda item b) the co-chairs had sent out a questionnaire on the use of indicators (and also IEA) in GEF-supported LME projects. Responses were received from six projects (Agulhas-Somali Current, Bay of Bengal, Canary Current, Humboldt Current, Sulu Celebes Seas, and Yellow Sea LMEs; three of them after the meeting). Rudolf Hermes presented a summary of the responses to the questionnaire. Most of the indicators reflected progress in project implementation and there was limited development of indicators related to the state of the ecosystem. In this session, there were also presentations on indicator work in FAO (Gabriella Bianchi), OSPAR (Andrea Belgrano), and IndiSeas (Gro I. van der Meeren).

ICES is producing ecosystem overviews (agenda item d). Gro I. van der Meeren presented experiences from preparation of ecosystem overviews for the Barents and Norwegian Seas in the two ICES groups: the Working Group on the Integrated Assessments of the Barents Sea (WGIBAR) and the Working Group on the Integrated Assessments of the Norwegian Sea (WGINOR). In providing information on human activities and pressures it is important to explicitly state whether scaling is for extent vs. effects of activities on ecosystem components. The latter depends on proper assessments being carried out, and documentation for the information in ecosystem overviews should be found in the more extensive IEAs.

Regarding agenda item d) on areas of collaboration and mutual interest between ICES and LME groups, the new project ‘LME Learn’ was noted. LME Learn is established by GEF and carried out by IOC in cooperation with other partners including ICES. A new ‘working group’ under LME Learn has similar scope as WGLMEBP and there is a need to consider the relationship between WGLMEBP and LME Learn in follow-up work for the next 3-year period from 2017.
## Administrative details

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<th>Working Group name</th>
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| Chair(s) | Hein Rune Skjoldal, Norway  
Rudolf Hermes, Thailand |
| Meeting venue | Paris, France |
| Meeting dates | 28 September - 2 October 2015 |
2 Terms of Reference a) – e)

<table>
<thead>
<tr>
<th>ToR</th>
<th>Description</th>
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<tr>
<td>a</td>
<td>Gather information about past and current integrated ecosystem assessments (IEA) into an inventory of IEAs, their geographic scope or scale, and the reference points used.</td>
<td>incorporate the results of WGNARS, WGINOSE, WGEAWESS, WGINOR, WGIBAR and WGIAB</td>
<td>new science plan</td>
<td>Year 1</td>
<td>An inventory of IEA's</td>
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<td>b</td>
<td>With support from ICES scientists and LME practitioners, and based on the above output, develop a brief synthesis of the most commonly used science-based indicators for ecosystem-based management. Consider to conduct a survey among practitioners using a questionnaire.</td>
<td>a) review and consider the different concepts in use based on published knowledge</td>
<td></td>
<td>Year 1</td>
<td>The synthesis, possibly a peer reviewed publication and other communication tools to disseminate these findings</td>
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<td>c</td>
<td>Identifying LME units as references for IEA, in the ICES area (including the Arctic LME's), as well as in the operational LME's;</td>
<td>a) consider the relevant LME delimitations for practical use</td>
<td></td>
<td>Year 1</td>
<td>agreed reference LME units</td>
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<td>d</td>
<td>Taking into account the results of WKECOVER earlier in 2013, apply the criteria proposed for producing ecosystem overviews and develop in cooperation with LMEs overviews for ICES core areas, Arctic and other LMEs as far as possible, also in partnership with PICES, NOAA, CSIRO etc.</td>
<td>a) WKECOVER report</td>
<td></td>
<td>Year 2 and 3</td>
<td>Overviews</td>
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<td>e</td>
<td>Identify areas of collaboration and mutual interest between ICES and</td>
<td>a) consider science requirements</td>
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<td>Identification of: Areas of common interest,</td>
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<td>including; knowledge transfer; communication and capacity development.</td>
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### 3 Summary of the Work Plan

- **Year 1** based on published literature, LME and ICES IEA EGs produce an inventory of existing or planned IEAs and a synthesis document with recommendations; identification of reference LME
- **Year 2** attempt ecosystem overviews for operational LMEs and Arctic LMEs, as well as take into account the ecosystem overviews for the ICES core areas
- **Year 3** partnerships, knowledge transfer and training needs
4 Progress report on ToRs and workplan

4.1 Introduction and format of the meeting

The Working Group on Large Marine Ecosystem Programme Best Practices (WGLMEBP) met at UNESCO IOC in Paris for three days in late September. This was the second meeting of work according to the multi-annual terms of reference (2013/MA2/SSGRSP06). The meeting was carried out as part of the weeklong meetings on LMEs at IOC, including the 17th Annual Consultative Meeting on Large Marine Ecosystems and Coastal Partners, 29 September – 2 October 2015. The ICES WGLMEBP meeting was carried out in three separate sessions according to the agenda which is enclosed as Annex 1. The first two sessions were held on 28 and 29 September before the start of the 17th Consultative LME meeting, while the third session was held in parallel with a session of regional caucuses of the 17th LME meeting on 30 September. A brief report from the WGLMEBP meeting was given to the plenary of the 17th LME meeting later on 30 September.

The WGLMEBP was attended by 22 participants (Annex 2).

The agenda was structured according to the five issues on the ToRs, which in brief are:

a) Inventory of Integrated Ecosystem Assessments (IEAs);

b) Use of science-based indicators;

c) Identify LME units in the ICES area;

d) Produce ecosystem overviews for LMEs;

e) Identify areas of collaboration.

Four of these items (except d) were dealt with initially at the meeting in 2014 (see ICES WGLMEBP 2014 Report). At the 2015 meeting we continued review and discussions of the items, as reflected in this report. The aim is to prepare a more complete synthesis, building on the 2014 and 2015 reports, at the third meeting next year (2016).

At this year’s meeting we had several introductory or overview presentations at the beginning of the agenda items. Summaries of the presentations are given in the following parts of this report along with summaries of the outcome of discussions.

4.2 Agenda item a) – Gather information about past and current integrated ecosystem assessments (IEA) into an inventory of IEAs, their geographic scope or scale, and the reference points used

ICES puts much emphasis on ecosystem understanding and Integrated Ecosystem Assessment (IEA) in its current Strategic Plan (2014–2018):

“The ICES Strategic Plan commits to building a foundation of science around one key challenge; integrated ecosystem understanding. ICES will produce integrated ecosystem assessments in regional seas as a fundamental link between ecosystem science and the advice required in applying the ecosystem approach.”

ICES has established six regional groups for IEA of several Large Marine Ecosystems or Ecoregions (Figure 1). These groups are producing annual reports with contain
elements and examples of IEA for LMEs or smaller scale systems (e.g. the Northwest Atlantic group).

Figure 1. ICES working groups for IEA of regional ecosystems. For several regions, e.g. Barents, Norwegian, Baltic, and North seas, the regions are equivalent to LMEs.

Another example of IEAs is provided by the IEA program of the US NOAA. This was presented by Rebecca (Becky) Shuford and further information is given in the summary of her presentation below. Becky also gave a short summary from the theme session on IEA at the ICES Annual Science Conference in September 2014.

We aim to produce an inventory as an annotated list of IEA reports in our next and final 3-year term report (2016). This will include information on any IEA work in the GEF-supported LME projects at lower latitudes. Some initial information on this topic is included in the next agenda item as response to the questionnaire on indicators and IEA, which we sent to LME projects.
Presentation – Overview of IEA concepts and development

Rebecca Shuford, NOAA

As contribution to WGLMEBP terms of reference a) “Gather information about past and current integrated ecosystem assessments (IEA) into an inventory of IEAs, their geographic scope or scale, and the reference points used”, Rebecca Shuford from US National Oceanographic and Atmospheric Administration (NOAA) provided a presentation on Ecosystem-based management (EBM/EA) and IEAs.

The presentation was generally in two parts. The first element provided (a) some fundamental points and concepts that highlight the construct of EBM/EA and IEAs as a mechanism to achieve this. This aspect of the talk pulled from content from a special IEA theme session (One size does not fit all. What does an IEA mean to you?) at the 2014 ICES Annual Science Conference (ASC), including framing thoughts from the co-conveners’ presentation (Rebecca Shuford, Hein Rune Skjoldal, Robin Anderson) and principle observations and outcomes synthesized from the overall session. The second element (b) focused on NOAA’s approach to IEAs:

Fundamental thoughts and definitions for EBM/EA and IEA:

- The definition of “integrated!” provides a concise and simple perspective on what we are trying to achieve with EBM/EA and IEA, and is relevant in both a science and a management context (i.e. integrating between science components; integrating across management objectives)

- ICES (Skjoldal and Misund, 2008) provides a useful and comprehensive definition of EBM/EA: “the comprehensive integrated management of human activities based on the best available scientific and traditional knowledge of the ecosystem and its dynamics, in order to identify and take action on influences which are critical to the health of marine ecosystems, thereby achieving sustainable use of ecosystem goods and services and maintenance of ecosystem integrity”

- EBM/EA is a continuum along a spectrum of levels of integration from no EBM to incremental EBM to comprehensive EBM; and this continuum can be viewed in two complementary dimensions (i.e. vertically within a sector and horizontally across sectors).

- IEA is a central component to achieving EBM/EA and is a bridge between science and advice.

- Key outcomes from the special theme session can be found in the session report at:
  http://www.ices.dk/news-and-events/asc/ASC-2014/Programme/Pages/Theme-Sessions.aspx

NOAA’s IEA (www.noaa.gov/iea):

- NOAA’s IEA is a comprehensive decision-support process that synthesizes and analyses diverse data and ecosystem model outputs to provide the analytical framework for EBM/EA.

1 “to make whole or complete by adding or bringing together parts; to put or bring (parts) together into a whole, unify” (Webster’s New World College Dictionary)
• It has a common national framework that allows regional variation in implementation and is modular, iterative, scalable, and adaptable.

• The approach assesses ecosystem status relative to societal, economic, and ecological goals and objectives and evaluates the benefits, risks, and trade-offs of alternative management actions from social and ecological perspectives to inform management decisions.

• The strength and benefit of NOAA’s IEA approach is that it will result in better informed decision-making. They are a science-based stepwise process implemented with stakeholders and managers to provide robust decision-support information in an ecosystem context.

• NOAA’s IEA program is already providing information and products to support decision-making processes in, for example, Fishery Management Councils, National Marine Sanctuaries, and US Regional Planning Bodies and Ocean Councils.

4.3 Agenda item b) – Develop a brief synthesis of the most commonly used science-based indicators for ecosystem-based management

By way of introduction, Hein Rune Skjoldal noted the complexity of the indicator issue and the importance of a clear terminology. Parameters and variables are terms used in traditional science whereas indicators and indicator frameworks are now commonly used to characterize and represent complex natural systems and the couplings to social and economic systems, which are also complex. Indicators are of different types and can be used for different purposes. The DPSIR framework (Driving force – Pressure – State – Impact – Response) is one example, which illustrates different types of indicators used in a causal-chain context. A difficulty here is that causal chains may not be easily recognized in open marine ecosystems since they are commonly embedded in networks connecting drivers and components of the ecosystem. Indicators (and indicator frameworks) may be used for various purposes such as auditing, assessment, and communication. When evaluating indicators it is important to state the types and purpose of the indicators under review.

The co-chairs had intersessionally sent out a questionnaire to LME projects requesting information on the use of indicators and IEA. Rudolf Hermes presented the questionnaire and responses received from LME projects. A summary of his presentation is given below. Three LME projects, the Bay of Bengal LME, the Humboldt Current LME, and the Sulu Celebes Seas LME, had provided information on the questionnaire. In the time after the meeting, three more LME projects provided information – Agulhas-Somali Current LME, Canary Current LME, and Yellow Sea LME. The responses to the questionnaire from all six LME projects are included as Annex 3.

Three more presentations were given in this session and summaries of the presentations are given below.

• Gabriella Bianchi presented work in the UN Food and Agriculture Organization (FAO) on developing indicators for the Ecosystem Approach to Fisheries.

• Andrea Belgrano presented work in OSPAR on developing biodiversity indicators in relation to the Marine Strategy Framework Directive (MSFD) of the European Union. Andrea is co-chair of the ICG-COBAM in OSPAR together with Peter Heslenfeld from The Netherlands.
Gro I. van der Meeren presented results from the work in the international IndiSeas program on development of indicators related to ecosystems and fisheries. More information from IndiSeas is given in Annex 4.

Presentation – Information on Indicator Use and Integrated Ecosystem Assessments (IEA) in LME Projects

Rudolf Hermes, Bay of Bengal Large Marine Ecosystem (BOBLME) Project

A questionnaire had been sent out to currently active and recently completed LME Projects with the aim to gather information on Integrated Ecosystem Assessments (IEA) and to develop a brief synthesis of the most commonly used science-based indicators for ecosystem-based management.

Aside from asking for project goal and key objectives, the questionnaire requested information on the following:

1) Which indicators have been (or are being) developed?
2) What is the state of their development (have they been developed and taken in use or are they under development)?
3) How are the indicators being (or intended being) used?
   a) How are they being reported?
   b) Are they used singly or combined into a holistic context?
   c) How do they form the basis for scientific advice?
   d) How do they inform management decisions?
4) Is an IEA prepared (or planned) as part of the implementation of LME projects?
5) What is the level of integration - ecosystem components, human pressures and impacts, socio-economics?

At the time of the WGLMEBP meeting, feedback from only three projects (Bay of Bengal LME, Humboldt Current LME, and Sulu Celebes Seas LME) had been received and is summarized as follows:

Project goals invariably invoke sustainable use or management of fisheries resources (and habitats), also mentioning improved governance (HCLME) and benefits to people (BOBLME). There are wide-ranging objectives, referring to capacity and livelihoods development, information and communication, science-based interventions, including fisheries management tools (MPAs, MCS, etc.), collaborative approaches, ecosystem health indicators – largely referring to improved processes, including development of the Strategic Action Programme.

It is therefore not surprising that the indicators developed also have a strong focus on processes (e.g. agreements, institutional arrangements, awareness, empowerment, partnerships, information dissemination, improved understanding, plan, and data protocol development), and only few consider reduction of environmental stresses (those relating to MPA management, illegal extractive activities, and fishing capacity) and even less on environmental status improvement (water quality parameters, habitat status).

Regarding the state of indicator development and use the communality was the purpose for the project monitoring and reporting system (regular GEF reporting), with additional remarks that they are used holistically, but require more research into
commercial fish species, while already informing National Park Authorities on MPA management effectiveness (HCLME). Both HCLME and BOBLME have opted to promote indicators developed independently: Ocean Health Index (HCLME) and Transboundary Waters Assessment Programme (BOBLME). Integration is also claimed – as all three projects use the framework of the ecosystem approach to (or ecosystem-based) management and have carried out the TDA-SAP process.

BOBLME had cooperated with TWAP relating to two of the LME modules: on nutrient pollution and governance assessments, and also carried out an “ecosystem characterization” exercise in collaboration with Australian CSIRO and assessment of fisheries management performance with SAUP-UBC (Seas Around Us Project, University of British Columbia).

In the HCLME, aside from OHI-type assessment there is also the promotion of Marine Spatial Planning and Ecosystem Risk Analysis for important fisheries of both project countries, but no specific IEA studies have been carried out or are planned.

As a way forward, it should be considered to improve and, to the extent possible, standardize or harmonize indicator development, prepare for IEA in Projects’ SAP development phase, but carry out IEA during SAP implementation phase, while promoting capacity development, institutional strengthening, regional collaboration – and further improvement of the science-policy interface.

Presentation – Work in FAO on developing EAF (Ecosystem Approach to Fisheries) Indicators

Gabriella Bianchi, FAO

FAO is developing guidance on indicators in support of the implementation of the Ecosystem Approach to Fisheries, including ecological, social, economic and governance indicators for fisheries management.

Key features of the EAF can be summarized as follows:

- it is participatory, at all levels of the planning and implementation steps;
- it is comprehensive, ensuring that all key components of the fishery system are taken into consideration, including those related to the ecological, social-economic and governance dimensions, while also taking into account external drivers;
- it encourages use of the ‘best available knowledge’ in decision-making, including both scientific and traditional knowledge, while promoting risk assessment/management and the notion that decision-making should take place also in lack of detailed scientific knowledge;
- it promotes the adoption of an adaptive management system and stresses the importance of establishing mechanisms for feedback loops at different time-scales to adjust the tactical and strategic performance based on past and present observations and experiences.

Practical implementation consists in developing EAF management plans for specific fisheries or regions through a comprehensive and participatory planning process. As part of this process key sustainability issues are identified for which management plans are required. Implementation of the plan entails identification of relevant and cost-effective indicators and their associated performance levels that can be used to monitor the success of the management plan in meeting agreed operational objec-
tives. Therefore, across the fishery, a combination of ecological, social, economic, and institutional indicators may be needed.

Indicators can be a quantitative or qualitative measure of some attribute of the fishery that is directly measured (e.g. spawning-stock biomass), estimated using a model (e.g. biomass estimated using a stock assessment model), measured indirectly (surrogate measures of biomass such as catch rates) or even just inferred (e.g. social unrest as an indicator of local attitudes to management). To interpret the indicator in relation to the operational objective, you need to determine what distinguishes acceptable performance from unacceptable performance with these performance measures (or reference levels) taking a number of forms (e.g. limits, targets, suitable ranges, trends, etc.).

A document is being finalized that reviews existing indicators, including for data-poor fisheries, to monitor sustainability of fisheries also in relation to impacts on non-target species, habitats, ecosystem structure, and functioning, social, economic and governance aspects of a fishery. External drivers (such as e.g. climate change) are also considered.

Presentation – OSPAR Intersessional Correspondence Group on the Coordination of Biodiversity Assessment and Monitoring (ICG-COBAM)

Andrea Belgrano and Peter Heslenfeld

Conveners OSPAR ICG–COBAM

OSPAR ICG-COBAM was established during OSPAR BDC in 2008 to focus on developing products for Biodiversity Monitoring and Assessment. In parallel, the European Commission established in 2008 the EU Marine Strategy Framework Directive (MSFD). OSPAR ICG-COBAM is currently developing, testing and assessing biodiversity indicators in relation to the MSFD Descriptors: D1, D2, D4, and D6. The work is developed for the OSPAR Maritime Region (Figure 2). ICG-COBAM is organized in seven expert groups: marine mammals, marine birds, fish and cephalopods, benthic habitats, foodwebs, pelagic habitats, and non-indigenous species.

The ICG-COBAM products will contribute to the OSPAR Integrated Assessment (IA) 2017 as part of the 2018 reporting time frame to the European Commission by Member States.

The summary record of the ICG-COBAM activities can be accessed via the OSPAR Commission webpage under Biological Diversity & Ecosystems following the ICG-COBAM links Meetings: http://www.ospar.org/work-areas/bdc
Presentation – IndiSeas indicator studies

Gro I. van der Meeren, IMR, Norway

Indiseas is a scientific program, which evaluates the effects of fishing on the health status of marine ecosystems. A panel of indicators is provided, characterizing the ecological and biodiversity status of exploited resources, their environment, and the human dimension of fisheries. The global program has been running since 2008 and finished the last period by December 2013 after collecting large amounts of data from up to 30 LMEs, by more than 70 scientists from 36 countries and 49 research institutions coordinated by Yunne Shin, Lynne Shannon, and Alida Bundy. IndiSeas originally developed a set of indicators for measuring impact of fisheries on LMEs (Shin et al., 2012) and followed up on this by also testing environmental and social indicators in the IndiSeas second phase. There are sets of criteria to be met by each indicator, as presented on the IndiSeas webpage http://www.indiseas.org. The descriptions of the ecological and biodiversity indicators are attached (Annex 4). Several papers are now published from IndiSeas 2 and more are in preparation.

This talk mentions the climate, environmental and human dimension indicators shortly but focus mostly on the ecological and biodiversity indicators. Here papers are mentioned, Relationships among fisheries exploitation, environmental conditions, and ecological indicators across a series of marine ecosystems (Fu et al., 2015), Evaluating changes in marine communities that provide ecosystem services through comparative assessments of community indicators (Kleisner et al., 2015) and Ecological indicators to capture the effects of fishing on biodiversity and conservation status of marine ecosystems (Coll et al., 2016).

The indicators selected for each of the presented papers showed that the indicator for fisheries was more sensitive to detect changes than the environmental ones (Fu et al., 2015). However, the conclusion was that the combination of both could be complementary and give a wider perception of the situation in each LME.
In Kleisner et al. (2015) only community indicators were used to evaluate changes in marine communities and ecosystem services. The ‘Non-declining exploited species’ indicator (NDES) provides a useful measure with which to gauge the ability of a marine ecosystem to sustainably provide wild seafood. It also provides a simple way to focus on exploited species and, through comparisons with community indicators that capture both the exploited and non-exploited portions of the ecosystem, evaluate the significance of such trends at the community level. However, multiple impacts of fishing (and other drivers) on marine ecosystems are difficult to track and assess concomitantly with any single indicator since multiple drivers from fishing to climate and habitat destruction are acting at multiple scales and on multiple processes in ecosystems.

Coll et al. (2016) used fisheries-related indicators from IndiSeas 1 and 2 from 29 LMEs, combined with the use of state and trend analyses, and correlation, redundancy and multivariate tests to study if the indicators provided useful additional information to refine the evaluation of marine exploited ecosystem status. Biodiversity and conservation-based indicators were found to be complementary to evaluate the overall impact of fishing. Although the indicators used in these studies were showing promising results, the response on the various LMEs showed that caution must be in place. The responses of indicators to pressures are not always linear. Indicators of fishing effort may not be ideal proxies of fishing pressure. The ecological indicators may respond to other extrinsic factors (e.g. environmental variables and drivers; Fu et al., 2015). In general, this emphasizes a real need to investigate the sensitivity and specificity of indicators to different drivers and their responsiveness to management thresholds and reference points (Shin et al., 2012).

Analyses of indicators assuming a linear relationship between response indicators and pressure indicators may be too simplistic. Detailed information about past and present exploitation strategies and management, main productivity mechanisms, and dominant ecological and environmental traits are essential elements to correctly interpret ecological indicators to inform on the status of marine exploited ecosystems.

**References**


4.4 Agenda item d) – Develop ecosystem overviews for LMEs in ICES core areas, Arctic and other LMEs as far as possible (in cooperation with LME projects)

Adi Kellermann from ICES provided an introduction to this item including some background information on the ICES Regional Seas (LME) overview programme. ICES attempted initially to prepare regional ecosystem descriptions (REDS). The focus was on where such ecosystem descriptions had been made, more than on what they actually looked like. It was stressed that it is not the ecosystems but the human activities that are needed to be managed. From the descriptive past, the focus has been moved to look at the pressures and stressors affecting the regional LMEs. The regional working groups for integrated ecosystem assessment are asked to deliver ecosystem overviews based on a template form, which has recently been revised. The second report on regional seas LME overviews are in preparation and will be published online by the end of this year (2015). The intention for these overviews is to support policy-makers, managers and stakeholders with easily accessible information for their regional seas.

Gro I. van der Meeren gave a presentation on experiences from preparing ecosystem overviews for the Barents Sea and the Norwegian Sea in two of the ICES regional IEA groups (WGI BAR and WGINOR). A summary of her presentation is given below. Gro noted the difficulty in scaling of human activities in the summary table and the need to make an explicit distinction between the extent of an activity and the resulting effect of the activity in the ecosystem. The latter requires that a careful assessment has been carried in the IEA which would allow a meaningful comparison of impacts of various activities.

In discussion it was noted that the problems of understanding and defining the scaling process and the documentation required for preparing the tables and flow charts in the ecosystem overviews need to be further discussed and solved. Inclusion of risk assessments in the overviews should be considered in future development of the overview process. These types of overviews, set up by ICES, accomplish the cross-sector assessments sought for, and should be a base for future IEAs (Sherman).

The ecosystem overviews provide information on linkages between human activities and pressures on the one hand and effects and impacts on ecosystem components on the other. This can provide some guidance to the assessment process when doing the IEA. It was noted, however, that care should be taken not to over interpret information. When an IEA has been conducted we are in a better position to prepare the tables and flow charts with more quantitative and better documented information.

Presentation: Experience from preparing the regional seas overview for the Barents Sea (WGIBAR) and Norwegian Sea (WGINOR)

Gro I. van der Meeren

The 2015 regional seas LME overview of the Barents Sea from WGIBAR, prepared at the meeting in June 2015 (ICES 2015a, b), and the draft overview for the Norwegian Sea, which will be updated by WGINOR at the meeting in December 2015, were presented. The overviews were prepared according to the second version template from ICES. The overviews present a set of key points, followed by a description of the human pressures, defined as fisheries, maritime activities, oil and gas production, offshore structures, military activities, coastal constructions, tourism and recreation, and
aquaculture. When available, maps are used to show the spatial extension or limitations of the human activities. Then it presents the state of ecosystem components: plankton, benthos, fish, birds, and mammals. The ecosystem structures were not presented in the talk as the aim of the overviews is put on the pressures from human activities. All the information are to be summarized in tables for each LME and used for preparing flow chart diagrams showing the relations to make the information easily accessible.

The tables have columns for scaling the strength of each activity in the form of pressures produced and the strength, which the pressures put upon each ecosystem component. Based on this scaling, a flow chart will be prepared, which shows the interrelated types of pressures on the different parts of the ecosystem. However, the scaling process was challenging since no guiding information was given for this procedure. In the two ecosystems presented here, the scaling was based on the spatial and temporal extent of each human activity, resulting in fisheries and extraction of species being scaled high (3) and the rest scaled low due to them being spatially restricted, or of short annual duration. Likewise, the pressures put on fish and benthos was scaled 3 and 2, respectively, from selective extraction of species and low (1) for all other pressures.

Based on the experience from producing these overviews, we feel some questions need to be asked:

- How and why the strength has to be scaled and how do we understand the 'strength' scale provided?
- What kind of facts and documentation is meant to support the information in the tables?
- How do we include high risks for impact, in activities that may induce little pressures during ordinary operation but have the potential for huge damage if accidents occur?
- There are some strong opinions against such a simplification of the human activity and pressure-issues as represented by the template tables. How are these opinions met?
4.5 Agenda item e) – Identify areas of collaboration and mutual interest between ICES and LME groups, including knowledge transfer, communication, and capacity development

The ICES WGLMEBP was established some years ago as a mean to provide support from ICES to LME projects and the broader LME community. At previous meetings, it has been recognized that ICES has much to offer in areas such as knowledge transfer, training, and capacity development. Areas where ICES can offer scientific support and advice are in fish stock assessments and the broader arena of doing IEAs. ICES has a long tradition of carrying out stock assessments and providing advice to fisheries management. ICES is also in the process of developing IEA through the regional ecosystem WGs and is considering how the IEAs can be used in an advice context within the broader EA.

‘LME Learn’ is a new project established by GEF (Global Environment Facility) and is operated by IOC in cooperation with other UN agencies and other partners including ICES. LME Learn met on Monday 28 September in parallel with the meeting of WGLMEBP. The outcome of the meeting was reported back to the plenary of the 17th LME meeting and the agenda of the latter was structured with reference to LME Learn under the various agenda items.

LME Learn has general objectives similar to WGLMEBP by providing a mechanism and forum for exchange of information and experiences related to LMEs and their assessment and management. LME Learn plans to establish ‘working groups’, one of them on scientific and technical aspects related to assessment and management of LMEs. This is similar to some of the aspects of the work of WGLMEBP and there is a need to clarify the relationship between the new group under LME Learn and WGLMEBP. ICES is a partner in LME Learn but so far with participation only from the ICES Secretariat level.

On the basis of the new developments with LME Learn there is a need to redefine the purpose and scope of the work of WGLMEBP. One option could be to merge WGLMEBP and the new group under LME Learn into a joint ICES/IOC/+? WGLME. Another option is to end WGLMEBP after completion of the current 3-year work plan (2014–2016). A third option is to continue WGLMEBP with a new set of ToRs for another 3-year period. This needs to be discussed intersessionally and at the next meeting of WGLMEBP in 2016 with a conclusion reached when the work plan for 2017 is formally adopted by ICES.

4.6 Agenda item c) – Identifying LME units as references for IEA, in the ICES area (including the Arctic LME’s), as well as in the operational LME’s

There was little discussion on this item at the meeting and reference is made to the 2014 WGLMEBP report.

A revised map of 18 Arctic LMEs was adopted by the Arctic Council in 2013 (Figure 3). The Arctic area as used in the work of the Arctic Council includes the Barents Sea and Norwegian Sea LMEs and the LMEs around Iceland and the Faroe Islands. These LMEs are in the core ICES area where ICES provides advice to fishery management.

There are some remaining LME boundary issues between the Arctic LMEs and boreal LMEs such as the North Sea and Celtic Seas in the Northeast Atlantic, and also in the Northwest Atlantic e.g. in relation to the Labrador and Irminger Seas. These issues
are complex both from scientific and political/management perspectives (e.g. EU MSFD regions).

Figure 3. Map of 18 LMEs of the Arctic (www.pame.is)
5 Next meeting

The next meeting is planned to be held at UNESCO IOC, in Paris, during the same week as the 18th Annual Consultative Meeting on Large Marine Ecosystems and Coastal Partners. The dates are to be decided in consultation with IOC and other partners.
Annex 1. WGLMEBP – Agenda

DRAFT AGENDA

The meeting will be from Monday 28 September after lunch to Wednesday 30 September.

The meeting will address 5 issues which are items on a multi-annual Terms of Reference (ToR) given by ICES (2014–2016). In brief the 5 items are:

a) Inventory of Integrated Ecosystem Assessments (IEAs)

b) Use of science-based indicators

c) Identify LME units in the ICES area

d) Produce ecosystem overviews for LMEs

e) Identify areas of collaboration

Monday 28 September

14:00-14:45 Welcome, introduction, adoption of agenda

14:45-15:45 Agenda item a) Gather information about past and current integrated ecosystem assessments (IEA) into an inventory of IEAs, their geographic scope or scale, and the reference points used

15:45-16:15 Comfort break

16:15-17:30 Agenda item b) Develop a brief synthesis of the most commonly used science-based indicators for ecosystem-based management

Tuesday 29 September

09:00-10:45 Agenda item d) Develop ecosystem overviews for LMEs in ICES core areas, Arctic and other LMEs as far as possible (in cooperation with LME projects)

10:45-11:15 Comfort break

11:15-13:00 Agenda item e) Identify areas of collaboration and mutual interest between ICES and LME groups, including knowledge transfer, communication and capacity development

Wednesday 30 September 2015

09:00-10:45 Agenda item c) Identifying LME units as references for IEA, in the ICES area (including the Arctic LME’s), as well as in the operational LME’s

10:45-11:15 Comfort break

11:15-13:00 Continue and wrap up of agenda items a)-e) where needed

13:00 End of meeting
## Annex 2. WGLMEBP – List of participants

<table>
<thead>
<tr>
<th>Name</th>
<th>Institute</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
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</tr>
</tbody>
</table>
### Annex 3. Responses to questionnaire on use of indicators in LME projects

<table>
<thead>
<tr>
<th>PERIOD</th>
<th>ASCLME</th>
<th>BOBLME</th>
<th>CCLME</th>
</tr>
</thead>
<tbody>
<tr>
<td>JAN 2008 – MAR 2014</td>
<td>Programme Goal</td>
<td>Global Environment Objective:</td>
<td>Project purpose:</td>
</tr>
<tr>
<td></td>
<td>“To ensure the long-term sustainability of the living resources of the ASCLME through an ecosystem-based approach to management”</td>
<td>A healthy ecosystem and sustainability of living resources for the benefit of the coastal populations of the Bay of Bengal Large Marine Ecosystem (BOBLME).</td>
<td>‘To enable the countries of the Canary Current Large Marine Ecosystem to address priority transboundary concerns on declining fisheries, associated biodiversity and water quality through governance reforms, investments and management programs’.</td>
</tr>
<tr>
<td></td>
<td>Project Objective</td>
<td>Development Objective:</td>
<td>Key project expected outcomes:</td>
</tr>
<tr>
<td></td>
<td>“to undertake an environmental baseline assessment of the Agulhas and Somali Current Large Marine Ecosystems to fill information gaps needed to improve management decision-making, and to ascertain the role of external forcing functions (such as the Mascarene Plateau and the Southern Equatorial Current). This information will be used to develop a TDA and SAP for the Agulhas Current LME, and a TDA for the southern portion of the Somali Current LME”.</td>
<td>To support a series of strategic interventions that would result in, and provide critical inputs, into the Strategic Action Programme (SAP), whose implementation will lead to enhanced food security and reduced poverty for coastal communities.</td>
<td>(i) Multi-country agreement on priority transboundary issues;</td>
</tr>
<tr>
<td></td>
<td>Outcome 1 Key ecosystem assessment and management gaps are filled as necessary to install an ecosystem approach to LME management</td>
<td>Component 1. Strategic Action Programme</td>
<td>(ii) Multi-country agreement on governance reforms and investments to address priority transboundary issues;</td>
</tr>
<tr>
<td></td>
<td>Outcome 2 Decision-making tools are in place, to facilitate the synthesis and application of data for LME management;</td>
<td>Objective: To prepare a Strategic Action Programme (SAP) whose implementation will ensure the long-term institutional and financial sustainability of the BOBLME Programme;</td>
<td>(iii) A sustainable legal/institutional framework for the CCLME;</td>
</tr>
<tr>
<td></td>
<td>Outcome 3 Regional agreement is reached on transboundary priorities and their root causes and a suite of governance reforms and investments needed to institute a shared</td>
<td>Component 2. Coastal/Marine Natural Resources Management and Sustainable Use</td>
<td>(iv) Strengthened existing transboundary waters institutions and regional policies and instruments;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Objective: To promote the development and implementation of demonstrative regional and subregional collaborative approaches to address priority common and/or shared natural resource issues which affect the health and status of BOBLME;</td>
<td>(v) Stakeholders’ involvement in transboundary water body priority setting and strategic planning, including 7 functioning National Inter-Ministry Committees;</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Component 3. Improved Understanding and Predictability of the BOBLME Environment</td>
<td>(vi) Improved knowledge and capacity to address concerns on</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Objective: To support activities and participate and share information with other regional and global environmental monitoring programmes which will lead to better understanding of the BOBLME ecological functions and processes;</td>
<td></td>
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</tbody>
</table>
Outcome 4 A Comprehensive Public Participation Initiative Enables Stakeholders to Engage in Programme activities.  

1. Which indicators have been (or are being) developed?

a) an assessment was carried out of all national monitoring programmes (as part of the process of development of the national Marine Ecosystem Diagnostic Analysis).

b) the causal chain analyses confirmed what needed to be measured.

c) a suite of over 100 potential indicators was developed – mainly ecosystem (biophysical and socio-economic), parameters to be monitored and data gathering/management partners were identified.

PDO

A regional SAP establishing priorities for action (policy, legal and institutional reform and investments) to resolve priority transboundary environmental problems in the BOB LME, and endorsed and adopted by the participating governments. Proposed actions in the SAP address the well-being of coastal communities through promoting regional approaches to resolving resource issues and barriers affecting their livelihoods.

Outcome 1

Updated and revised TDA (from FTDA) based on post-tsunami update and gap analysis.

Final Transboundary Diagnostic Analysis to identify environmental concerns and root causes of environmental degradation completed through an effective inter-governmental process and adopted by respective governments.

Institutional arrangements agreed to and established for the long-term management of the BOB LME.

Recommendations for financial sustainability formulated and endorsed.

Regional level SAP completed and adopted.

Eight National Actions Plans (NAPs) under development.

Full-size project proposal for second phase of BOB LME programme (SAP implementation) submitted to the GEF.
Outcome 2
Learning and adopting best ICM practice benefits coastal communities. Strengthened policy formulation capacity and provision of advice on policy formulation in support of community-based integrated coastal fisheries management (ICM). Regional statistical data protocols developed and data quality and access to data improved. Three fishery management plans (sharks, hilsa, and Indian mackerel) developed and submitted to governments for their consideration. Two bi-national management plans for critical transboundary ecosystems developed and submitted to the respective governments.

Outcome 3
Agreed to address key data gaps serving as barriers to improving understanding of large-scale oceanographic and ecological processes controlling BOB LME living marine resources. A regional MPA/fish refugia inventory accompanied by a gap analysis, conclusions and recommendations. Partnerships established with regional and global environmental programmes and effective sharing of information in improving understanding of BOB LME processes.

Outcome 4
Establishment of agreed to LME based ecosystem health indicators. A set of conclusions and recommendations to participating countries for the harmonization of BOB LME water quality standards. Agreed work plan that would lead to identification of a regional approach to address land-based sources of pollution in the BOB LME.

Outcome 5
An RCU is initially staffed and functioning in a temporary location. Process of establishing a permanent location and staffing sustainable fisheries completed Concerted CCLME regional fisheries management policy Management guidelines on spawning areas and other critical fisheries habitats Demo 1: At least one shared small pelagic stock management plan Demo 2: Reduced trawling bycatch demonstrated at two CCLME sites Demo 3: Multi-country agreement on at least 2 coastal pelagic species Demo 4: Guidelines for co-management of fisheries in MPAs agreed by a subregional working group.

Component 3
General assessment and report of data and information including policy and legislation gaps for the TDA and compilation of existing data in relation to pollution and ecosystem health in the CCLME region Critical habitats management and monitoring Regional Programme of Action on Land-based Activities Contingency plan to prevent and mitigate offshore petroleum pollution Demo 5: Restoration of a
## Recommendations

Requirements for the RCU are completed.

Recommendations for ensuring an effective and efficient RCU received and acted upon by the Project Steering Committee (PSC).

Regional cooperation is promoted through a minimum of five meetings of the PSC.

A project monitoring and reporting programme is established and under implementation.

A project communications plan is recommended, discussed and approved by the PSC, and under implementation.

Project results and lessons learned disseminated.

### Table: Project Indicators and Usage

<table>
<thead>
<tr>
<th>ASCLME</th>
<th>BOBLME</th>
<th>CCLME</th>
</tr>
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<tbody>
<tr>
<td><strong>2. What is the state of their development (have they been developed and taken in use or are they under development)?</strong></td>
<td>Under development. The potential list has been finalized but it is not feasible for implementation as such – far too complex and too many indicators. A subset of 10-15 should ideally be chosen moving forward (by the SAPPHIRE Project when it starts)</td>
<td>Targets were at times modified; mostly attained.</td>
</tr>
<tr>
<td><strong>3. How are the indicators being (or intended being) used?</strong></td>
<td>They would mostly be reported on an annual basis and feed into management / decision-making processes. Some could be reported more frequently, or on a needs basis, such as would be the case with the currently developing El Niño. But at the very least an annual basis.</td>
<td>Project monitoring and reporting system</td>
</tr>
<tr>
<td><strong>3.1 How are they being reported?</strong></td>
<td>Regular GEF reporting</td>
<td>The results are communicated by reports and during meetings like project CCLME Steering Committee and other sub regional meeting</td>
</tr>
<tr>
<td><strong>3.2 Are they used singly or</strong></td>
<td>Mostly singly</td>
<td>Management plan, recommendation and guidelines</td>
</tr>
</tbody>
</table>
### Table 1: Comparing the Processes of LME Projects

<table>
<thead>
<tr>
<th>ASCLME Period</th>
<th>BOBLME Period</th>
<th>CCLME Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combined into a holistic context?</td>
<td>Mostly used for project management</td>
<td>Analysis of data collected during survey and activities on the field support the scientific advice</td>
</tr>
<tr>
<td>3.3 How do they form the basis for scientific advice?</td>
<td>Knowledge products are made available for management and policy development</td>
<td>By report, sensitization and during meetings</td>
</tr>
<tr>
<td>3.4 How do they inform management decisions?</td>
<td>Each country prepared a multi-sectoral national Marine Ecosystem Diagnostic Analysis. Copies of these can be provided</td>
<td>Planned during SAP implementation</td>
</tr>
<tr>
<td>4. Is an IEA prepared (or planned) as part of the implementation of LME projects?</td>
<td>No</td>
<td>The Bay of Bengal Large Marine Ecosystem (BOBLME) Project requested CSIRO to deliver an ecosystem characterization for the Bay of Bengal marine systems. To achieve this CSIRO integrated information from available science reporting, input from experts in the region and data from available spatial data layers to provide a description of the Bay of Bengal marine systems. Biophysical characteristics and drivers of the marine communities (e.g. depth, geomorphology, oceanography) are used within a hierarchically structured framework to explain differences in species and community structures, at a range of scales, from large ocean basin to province (see Chapter 6). This approach involves considering the broad set of regional systems and drivers that are differentiated by large-scale oceanographic drivers. A regional set of systems and subregions was then defined based primarily on differences in the processes operating on the continental shelf, the continental slope and the deep ocean or abyssal plains. Following that, subregions were defined based on differences in other important habitat drivers such as water temperature, current patterns and geomorphology, as communicated to national authorities via National Inter-ministerial Committee and promoted during specific meeting like forum and Ministerial conference</td>
</tr>
</tbody>
</table>

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Note: Planned during SAP implementation.
such that each subregion has a unique combination of habitats, communities and other features. Important ecological features and more specific processes associated with those features were also used to help identify major subregions. These subregions, defined as provinces, are used as the main unit for characterizing the ecological systems within the BOBLME.

The approach used in the Bay of Bengal Large Marine Ecosystem (BOBLME) ecosystem characterization was developed by CSIRO through a series of projects on Australia's regional marine planning program. The BOBLME Project contracted CSIRO to collate and synthesize available data and expert information in order to characterize and describe the ecosystems, subsystems, linkages across systems, and the large-scale drivers of these systems in the Bay of Bengal. It is expected that this will lead to a better understanding of how the BOBLME ecological systems function as a whole and subregionally.


Indicators identified by the Transboundary Waters Assessment Programme (TWAP-UNEP) adopted and promoted

Fish and Fisheries

The eight maritime countries in the FAO Bay of Bengal Large Marine Ecosystem (BOBLME) were assessed as to their sustainable use of the resources within their Exclusive Economic Zones (EEZs), using fourteen indicators of marine living resource management.
These indicators assessed MPA investment as well as area coverage, the impact of trawling and other habitat damaging gears, mariculture sustainability, the protection of seabirds and marine mammals, ecosystem impacts, economic health, levels of taxonomic reporting of commercially caught species, and compliance with the FAO Code of Conduct for Responsible Fisheries. With the exception of the Marine Trophic Index (MTI) and the Stock Status plots (SSPs), each of the remaining 12 indicators was computed at the EEZ level (or the Bay of Bengal portion of the EEZ when appropriate), and ranked from lowest to highest on a scale of 0 to 10. The MTI and SSPs are presented qualitatively as time-series graphs (1950–2006) and a discussion of the possible implications of the trends is presented. For the 12 ranked indicators, four rankings of the countries are presented, based on the management preferences identified by the Global Environmental Outlook (GEO4) future development scenarios: Market First; Policy First; Security First; and Sustainability First.


BOBLME (2011) Performance in managing marine resources in the Bay of Bengal (BOBLME-2011-Ecology-17)

9- Nutrients

BOBLME (2014) Understanding nutrient loading and sources in the Bay of Bengal Large Marine Ecosystem (BOBLME-2014-Ecology-18)


River inputs of nitrogen (N), phosphorus (P) and dissolved silica (DSi) from watersheds draining in to the Bay of Bengal Large

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2 In areas other than the Bay of Bengal, this indicator may also include dredging, which modifies bottom habitats even more than bottom trawling (Chuenpagdee et al., 2003).

3 Based on global taxon-gear associations (Watson et al., 2006a, 2006b).
Marine Ecosystem (BOBLME) for contemporary conditions, and for one future scenario for the years 2030 and 2050 as calculated by the Global NEWS model are presented. The major N and P sources are identified, and the Indicator of Coastal Eutrophication (ICEP) is calculated for rivers draining into the BOBLME. In 2000, a total of 7.1 Tg N and 1.5 Tg P was transported to the mouth of rivers in the BOBLME. Three rivers (Ganges, Godavari, Irrawaddy) account to approximately 75–80% of the total river transport of N and P. Based on the scenario analysis, by 2050 the river N load is projected to increase to 8.6 Tg, while the P load is not expected to change much. This is the net effect of increasing loads for dissolved N and P, and decreasing loads for particulate N and P.

Rivers draining into the western BOBLME generally have higher N and P export compared to eastern BOBLME rivers. The dominant sources of the different forms of N and P differ across basins; however, anthropogenic sources usually dominate both N and P in western BOBLME basins. Future changes in nutrient export, as well as the relative contribution of different sources, are projected to be quite variable among rivers. The increases in dissolved N and P export can be large, up to more than a factor of 5 for DIP and more than a doubling for DIN and DON. The increases in dissolved N and P loads are associated primarily with increased N and P in agriculture and with an increasing population and economic development. Particulate N and P export in many basins are projected to decrease and are associated with changes in hydrology and with damming of rivers. Based on nutrient export ratios (N and P relative to DSi) we generally calculate positive ICEP values for BOBLME rivers, indicating a risk for development of nonsiliceous algal species which can potentially produce toxins and otherwise disrupt nearshore coastal ecosystems. In future the risk for coastal eutrophication may increase due to both changing nutrient ratios (ICEP) and increasing nutrient loads. Effective management of coastal eutrophication calls for a basin-specific approach.
Assessment of transboundary governance architecture for the Bay of Bengal LME (Revision 1) (Robin Mahon, Lucia Fanning)

This assessment of transboundary governance arrangements in the Bay of Bengal Large Marine Ecosystem (BOBLME) builds on a previous assessment carried out by the GEF Transboundary Waters assessment Programme (TWAP). It focuses on the characteristics of the governance arrangements in place for key transboundary issues: fisheries, overexploitation, pollution, habitat destruction and biodiversity, as identified by the BOBLME Transboundary Diagnostic Analysis (TDA). Twelve intergovernmental agreements and a number of NGOs, programmes and projects relevant to the area were found. These indicate considerable activity in setting up mechanisms to address transboundary issues.

Eleven arrangements with specific responsibility for the above issues were found. They had an average of 54% completeness (the indicator ranges form 0–100%). This was measured by the extent to which the stages of the policy cycles of the arrangements reflected ‘good governance’ according to a set of normative criteria. Scores for individual policy cycle stages varied considerable among arrangements but were generally lowest for the decision-making and implementation stages of the process.

The extent of integration among these arrangements was estimated and found to be very low. There is no body or mechanism in place for the integration across issues that is required for effective ecosystem based management. Whereas engagement of countries in the arrangements was relatively high, as evidenced by the extent to which they had ‘signed on’ to the respective agreements, there was a significant incidence of cases where countries of the region were not eligible to join agreements that pertained to the Bay of Bengal or significant parts of it. Finally, there was a considerable incidence of mismatch between the area covered by the various agreements and the BOBLME. In some cases the agreement covered only part of the Bay of Bengal. In others it included the BOBLME but also included a much larger area. This mismatch is likely to be a significant impediment to effective governance.
<table>
<thead>
<tr>
<th>PERIOD</th>
<th>ASCLME</th>
<th>BOBLME</th>
<th>CCLME</th>
</tr>
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<tbody>
<tr>
<td>JAN 2008 – MAR 2014</td>
<td>In closing, it must be emphasized that the assessment is of the governance architecture of transboundary arrangements, not of their performance. It points to areas where architecture can be strengthened. There is however the need to go further and assess governance effectiveness within a framework that looks at the performance of processes in terms of meeting 'good governance' standards, as well as their impacts of ecosystem pressures, ecosystem status and ultimately well-being of marine resource users and coastal inhabitants. This ultimate assessment of governance effectiveness would be the next stage of a process of evaluating transboundary governance in the BOBLME. For socio-economics, SocMon (<a href="http://www.socmon.org">www.socmon.org</a>) is followed (Global SocMon network, South and Southeast Asia nodes)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>APR 2009 – DEC 2015</td>
<td>These were all covered in the MEDAS and taken further through national causal chain analyses for each country (facilitated the integration)</td>
<td>It is attempted to integrate – under an Ecosystem Approach to Fisheries Management (EAFM)</td>
<td>2010–2016</td>
</tr>
<tr>
<td>2010–2016</td>
<td></td>
<td>Ecosystem surveys conducted and multidisciplinary workshop organized</td>
<td></td>
</tr>
</tbody>
</table>
### Key objectives

**Project Goal:**
Advance towards a sustainably used and resilient HCLME that can maintain biological integrity and diversity and ecosystem services for current and future generations despite changing climatic and social pressures.

**Project Objective:**
Ecosystem-based management in the HCLME is advanced through a coordinated framework that provides for improved governance and the sustainable use of living marine resources and services.

The project has four specific Outcomes to deliver the Project Objective:

| Outcome 1: Planning and policy instruments for EBM of the HCLME – the development of the SAP. |
| Outcome 2: Institutional capacities strengthened for SAP implementation and for up-scaling the results of pilot interventions to the systems level. |
| Outcome 3: Implementation of priority MPA & fisheries management tools provides knowledge of options for enhanced protection of HCLME and SAP implementation. |
| Outcome 4: Implementation of pilot MPAs underpins ecosystem conservation and resilience. |

**Project title:**
Implementing the Strategic Action Programme for the Yellow Sea Large Marine Ecosystem (YSLME): Restoring Ecosystem Goods and Services and Consolidation of a Long-term Regional Environmental Governance Framework (YSLME II Project)

To achieve adaptive ecosystem-based management of the Yellow Sea Large Marine Ecosystem by fostering long-term sustainable institutional, policy, and financial arrangements for effective ecosystem-based management of the Yellow Sea in accordance with the YSLME Strategic Action Programme.

**Component 1.** Ensuring Sustainable regional and national cooperation for ecosystem based management, based on strengthened institutional structures, improved knowledge base and strengthened capacity for decision-making

**Component 2.** Improving Ecosystem Carrying Capacity with respect to provisioning services

**Component 3.** Improving Ecosystem Carrying Capacity with respect to Regulating and Cultural Services

**Component 4.** Improving Ecosystem Carrying Capacity with respect to supporting services
1. Which indicators have been (or are being) developed?

**Objective:**
Agreement on and understanding of the ecosystem-level issues of the HCLME as they relate to management of living marine resources (LMR) and biodiversity conservation. Increase in the % of fisheries management decisions that are based on integrated information on multispecific criteria and multidisciplinary parameters, including natural and ENSO-related variability

Increase in the number of certifiable fisheries

% increased awareness in identified target groups, of the benefits of applying EBM

**Outcome 1**
A Strategic Action Plan (SAP) developed based on updated ecosystem information and with an EBM approach is approved by both countries at the highest levels

National Action Plans (NAPs) developed within the SAP framework and approved in each country

% of the priority actions identified in plans that have secure financing: (a) regional level in SAP, and (b) national level in the NAP

Existence of short, medium and long-term targets for marine and coastal habitat conservation

Number of sectors represented and level of officials that participate in the national inter-sectoral committees

**HCLME**

<table>
<thead>
<tr>
<th>Period</th>
<th>Objective</th>
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</table>
| Sep 2010 – Mar 2016 | Theme 1: Science-based, social, and management interventions  
fish landings/catch are stable or increasing with constant cpue (5-year trend)  
amount of national funds allocated for small pelagic fisheries (SPF) management is secured or increasing  
extent and cover of habitats improving  
water quality parameters improving  
vulnerability of SPF and habitats to climate change decreasing  
**Theme 2: Resource Valuation**  
Improved government appreciation of fisheries total economic valuation (TEV)  
X number of published studies  
**Theme 3: Monitoring, Control, and Surveillance**  
Patrolling effort is regular and improved  
Apprehension records  
**Theme 4: Information, Education, and Communication (IEC)**  
X number of IEC materials disseminated  
X number of IEC materials developed and popularized  
Amount of government funds spent for IEC is secured or increased  
**Theme 5: Livelihood development**  
X number of livelihoods implemented  
Those involved in livelihood programs become less reliant on fishing  
Improved efficiency (less waste) with value added to products  
X number of publications on impact of fishing |

**SCSLME**

<table>
<thead>
<tr>
<th>Period</th>
<th>Objective</th>
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| 2010–1014 | Theme 1: Science-based, social, and management interventions  
fish landings/catch are stable or increasing with constant cpue (5-year trend)  
amount of national funds allocated for small pelagic fisheries (SPF) management is secured or increasing  
extent and cover of habitats improving  
water quality parameters improving  
vulnerability of SPF and habitats to climate change decreasing  
**Theme 2: Resource Valuation**  
Improved government appreciation of fisheries total economic valuation (TEV)  
X number of published studies  
**Theme 3: Monitoring, Control, and Surveillance**  
Patrolling effort is regular and improved  
Apprehension records  
**Theme 4: Information, Education, and Communication (IEC)**  
X number of IEC materials disseminated  
X number of IEC materials developed and popularized  
Amount of government funds spent for IEC is secured or increased  
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X number of livelihoods implemented  
Those involved in livelihood programs become less reliant on fishing  
Improved efficiency (less waste) with value added to products  
X number of publications on impact of fishing |

**YSLME**

<table>
<thead>
<tr>
<th>Component 1</th>
<th>Objective</th>
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| Status of YSLME Commission and subsidiary bodies at regional level  
Status of Inter-Ministerial Coordinating Committee (IMCC)  
Number of the YS Partnerships; Number of activities on capacity building and public awareness, Number of participants in capacity building activities  
Status of recognition and compliance to regional and international treaties and agreements  
Agreement on the financial arrangement for the YSLME Commission |

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<th>Component 2</th>
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| Number of fishing boats decommissioned from the fleet in YSLME waters  
Status of major commercially important fish stock from restocking and habitat improvement  
Type of mariculture production technology; and Level of pollutant discharge from mariculture operations |

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<th>Component 3</th>
<th>Objective</th>
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| Level of pollutant discharges particularly Nitrogen in YSLME tributaries  
Types of technologies applied for pollution reduction  
Status of legal and regulatory process to control pollution  
Status of the control of marine litter at selected locations |

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<th>Component 4</th>
<th>Objective</th>
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<td>HCLME</td>
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<tr>
<td><strong>Period</strong></td>
<td><strong>SEP 2010 – MAR 2016</strong></td>
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</table>
| **Outcome 2** | | **Areas of critical habitats;**
<p>| % of effective information exchanges in protocols defined within the framework of the Ecosystem Information System (EIS) | <strong>Note: successful livelihood program will result in reduction of fishing effort/fleet</strong> | <strong>Status of mitigation of reclamation impacts</strong> |
| % of staff profiles and procedures that are aligned with EBM in key institutions (i.e. CONAMA, MINAM, SUBPESCA, Vice-Minist. de Pesquería) | <strong>Theme 6: Capacity-building</strong> | <strong>Level of ecological connectivity in expansion of the Yellow Sea MPA system.</strong> |
| Key institutions (MINAM CONAMA, SUBPESCA), have the capacities and internal processes to prioritize the creation of new MPAs and to manage them effectively. Procedures defined and adopted to promote good fisheries practices and improve market competitiveness within the framework of the HCLME | More efficient/effective law enforcers and prosecutors/investigators result to less violations | <strong>Status of incorporation of adaptive management of climate change regional strategies and in ICM plans for selected coastal communities</strong> |
| Improved understanding of the benefits of ecosystem goods and services of artisanal fisher representatives that participate in fisheries fora | Successful local entrepreneurs become less reliant on fishing | <strong>Status of Regional Monitoring Network for application of ECBM</strong> |
| <strong>Outcome 3</strong> | | |
| Advances in adopting EBM for the shared anchovy stock as measured by the increase in agreed on and coordinated program of activities | The empowered spectrum of stakeholders has a collective sense of environmental stewardship. | |
| Adoption of coordinated management measures for the shared stock, such as closures, quotas and exclusion areas | | |
| Increase in hectares of the coastal-marine interface under improved management - measured by RNSIIIPG Master Plan and the tools for monitoring and management effectiveness measurement | | |
| Identification of equivalency in conservation management options (PAs) for coastal and | | |</p>
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<th>Period</th>
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<td>SEP 2010 – MAR 2016</td>
<td>2010–1014</td>
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<td>marine environments in both countries</td>
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<td>Number of best management practices developed in the project pilot sites that are up-scaled to other protected areas</td>
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<td><strong>Outcome 4</strong></td>
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<td>Increase in management effectiveness of the pilot MPAs measured: a) in Peru with Management Plans, b) with the Declaration of the area in Chile, c) Management effectiveness tracking tool (METT)</td>
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<td>Reduction in the incidence of illegal extractive activities in restricted areas established in the management plans of RNSIIPG pilot sites</td>
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<td>% management costs of the pilot areas protected that have secure financing</td>
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<td>Ecosystem-based management strategy for sea canyons agreed on by the relevant stakeholders</td>
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<td>Populations of flagship species at pilots (<em>Species will be selected in yr 1</em>)</td>
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2. What is the state of their development (have they been developed and taken in use or are they under development)?

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<tr>
<td>The initial logframe indicators are still being applied. New Ecosystem Quality Objective indicators have been developed in the context of the draft PAE (see attached documents). Furthermore the Ocean Health Index 10 indicators have been adopted as Peru’s official Ocean Health Index. As yet Chile is undecided.</td>
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3. How are the indicators being (or intended being) used?

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<tr>
<td>It is unclear now since the development of a functional Subcommittee on Sustainable Fisheries of the Sulu-Sulawesi Marine Ecoregion (SSME) has not begun and is now uncertain with the non-renewal of the Memorandum of Understanding among Indonesia, Malaysia, and Philippines. There</td>
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<td>The YSLME SAP, based on the TDA, have been developed and endorsed by two participating coastal countries (China and Korea) in 2009, respectively. It will be implemented when the YSLME II project is initiated.</td>
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are steps taken in the background to attain the objectives of the SSME under Goal 1 of the Coral Triangle Initiative on Coral Reefs, Fisheries, and Food Security (CTI CRFF). SSME was declared as a Priority Seascape under the CTI CRFF in 2010.

3.1 How are they being reported?
- Project Implementation reports and soon the Ocean Health Index (OHI) annual reports at the local (sub-national) level in Peru. Chile has yet to adopt the OHI as its Ocean Health national indicator.

3.2 Are they used singly or combined into a holistic context?
- Holistically.

3.3 How do they form the basis for scientific advice?
- There is a clear need for more research regarding the management of commercial species especially in Peru where a recent study carried out by TNC for the GEF Humboldt Project noted that: “There is very little biological, ecological and fisheries information available for 59 commercial finfish fisheries and 22 invertebrate fisheries”

3.4 How do they inform management decisions?
- The project indicators inform the state national parks authorities as to the current level of management effectiveness (see METT document).

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<td>SEP 2010 – MAR 2016</td>
<td>2010–1014</td>
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<tr>
<td>3.1 How are they being reported?</td>
<td>Project Implementation reports and soon the Ocean Health Index (OHI) annual reports at the local (sub-national) level in Peru. Chile has yet to adopt the OHI as its Ocean Health national indicator.</td>
<td></td>
<td>In a form of the project document for the YSLME II.</td>
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<tr>
<td>3.2 Are they used singly or combined into a holistic context?</td>
<td>Holistically.</td>
<td>With respect to ecosystem-based management, all indicators are in line with the outputs and outcomes of the SAP components.</td>
<td></td>
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<tr>
<td>3.3 How do they form the basis for scientific advice?</td>
<td>There is a clear need for more research regarding the management of commercial species especially in Peru where a recent study carried out by TNC for the GEF Humboldt Project noted that: “There is very little biological, ecological and fisheries information available for 59 commercial finfish fisheries and 22 invertebrate fisheries”</td>
<td>For the TDA, 4 Working Groups (Biodiversity including MPA, Fisheries and Aquaculture, Pollution and Ecosystem, and Investment including governance issues) consisting of national experts were organized, respectively. WGs identified the existing problems and threats in the YSLME. Such problems and threats were reflected in the regional SAP aiming at ensuring the sustainability of the YSLME, matching objectives of the YSLME II project with indicators.</td>
<td></td>
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<tr>
<td>3.4 How do they inform management decisions?</td>
<td>The project indicators inform the state national parks authorities as to the current level of management effectiveness (see METT document).</td>
<td>There is a decision-making body for the YSLME project, in terms of the Project Steering Committee (PSC). The PSC is a kind of the inter-governmental body of participating coastal countries, together with UNDP and UNOPS. A Regional Scientific and Technical Panel (RSTC), consisting of national experts and governmental officials of the participating countries, facilitated the</td>
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<td></td>
<td><strong>SEP 2010 – MAR 2016</strong></td>
<td>2010–2014</td>
<td>delivery of the results of WG meetings to the PSC.</td>
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<tr>
<td>4. Is an IEA prepared (or planned) as part of the implementation of LME projects?</td>
<td>We have carried out Ecosystem Diagnostic Analyses in both Chile and Peru as precursors for the TDA. In addition the Ocean Health Index assessments in a way form a kind of Integrated Ecosystem Assessment based on the 10 OHI indicators. Furthermore we are promoting Coastal Marine Spatial Planning in both Chile and Peru with assistance from NOAA. Ecosystem Risk Analysis work has been carried out for all the most important fisheries in both countries. This work involves a series of stakeholder, legal, social and ecological assessments similar to the IEA work. However no specific IEA studies have been carried out or are planned.</td>
<td>In a way, yes. The territorial scope of the TDA includes the watershed as socio-economic activities in this area could affect the habitat of coastal fisheries and mariculture. In the preparation of the Strategic Action Plan, the concept that was employed was the Ecosystem Approach to Fisheries management, which considers the ecosystem, socio-economic conditions, and the fisheries itself.</td>
<td>The concept of IEA is reflected in the YSLME II project documents in a holistic manner, in terms of the ecosystem-based management.</td>
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<tr>
<td>5. What is the level of integration - ecosystem components, human pressures and impacts, socio-economics?</td>
<td>Economic valuation of HCLME goods and services was completed in 2015 along with financial alternatives for national park management. The TDA-SAP process has delivered a series of objectives to promote EBM and the integration of these aspects.</td>
<td>At the planning stage right now. It will take a competent coordinator and manager to implement the different actions and to achieve the targets and its indicators.</td>
<td>As of 2010, approximately 600 million people live along the coastal areas of the YSLME. For their livelihood as well as local and national economy of participating countries, the quality of marine environment including marine living resources are important in the region. Nevertheless, there will be in depth discussion how to apply the ecosystem-based management in the YSLME when the YSLME II project is initiated, in particular to deal with cross-cutting issues covered by several different authorities at the national level. Several aspects of socio-economic assessment will be carried out during the YSLME II period.</td>
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Annex 4. Additional information on IndiSeas indicators

(lifted from http://www.indiseas.org)

Ecological indicators IndiSeas 2

**Total biomass of surveyed species** - total biomass of fish in the ecosystem is expected to decrease under fishing pressure. However, interpretation should be made with caution; in some cases, as species are fished and their biomass reduced, other species might increase in abundance and “replace” these species in the foodweb. For example, with the removal of top predators, lower trophic levels can be expected to increase. “Biomass” was not used to characterize the ecosystem state since survey data does not provide absolute estimates of biomass and thus is not comparable between species or ecosystems (due to differences in species catchability and surveys spatio-temporal coverage). Instead, “biomass” was used to compare biomass trends over time.

\[ \frac{1}{\text{landings /biomass}} \] measures the inverse level of exploitation or total fishing pressure on the ecosystem. This indicator varies in the same direction as the other indicators in the selected suite, as it decreases when fishing pressure increases. A decrease is considered negative for the exploited ecosystem. As for total biomass, this indicator is only used for comparison of trends since absolute estimates of biomass are generally not available.

**Mean length of fish in the community** is expected to decrease under fishing pressure for several reasons: (i) high-value and target species are generally large; (ii) fishing gears are size selective and often designed to remove larger fish and allow smaller ones to escape; (iii) older (and larger) fish in a population become fewer, because they accumulate the effects of fishing mortality through time; (iv) large sized species are more vulnerable because they have lower potential rates of increase. Mean length of fish is a measure of ecosystem functioning. From a single species perspective, the removal of larger fish, which are more fecund and produce more viable eggs than smaller fish, compromises productivity. From an ecosystem perspective, the removal of larger species changes the size structure of the community and potentially the predator–prey interactions.

**Trophic level of landings** measures the average trophic level of species exploited by the fishery, and is expected to decrease in response to fishing, since fisheries tend to target higher trophic level species. A decrease in trophic level of landings and total catch indicates “fishing down the foodweb”, and a change in the structure of the community and potentially ecosystem functioning. Trophic level of individual species is either estimated through modelling, or taken from global database such as FishBase.

**Proportion of predatory fish** is a measure of the diversity of fish in the community. Predatory fish are all surveyed fish species that are piscivorous, or feeds on invertebrates that are larger than 2 cm. The role of predators is important in an ecosystem as they regulate the abundance of the lower trophic level species, and they dampen the effects of environmental variability.

**Proportion of non-fully exploited stocks** reflects the success (or not) of fisheries management. Ideally, in a precautionary world and from a conservation point of view, all stocks should be non-fully exploited to ensure sustained biodiversity and sustainable ecosystems. “% of sustainable stocks” is a measure of conservation of biodiversity. The FAO classification of stocks as non-fully exploited
This classification was further reviewed and potentially refined adding local expert knowledge. This indicator is used to compare the state of ecosystems.

**Intrinsic vulnerability index (IVI) of the landings.** The intrinsic vulnerability index of a species (IVIs) is based on life-history traits and ecological characteristics, and ranges from 0 to 100, with 100 being most vulnerable. IVI of the landings is the mean IVI across all species landed, weighted by the contribution of each species to the landed catch. It is used as a trend indicator.

**Mean lifespan** is a proxy for mean turnover rate of species and communities, and is meant to reflect the buffering capacity of a system. The lifespan or longevity is a fixed parameter per species, and therefore the mean lifespan of a community will reflect the relative biomass of species with differential turnover rates. Fishing affects the longevity of a given species (direct effect of fishing and genotype selection), but the purpose here is to track changes in species composition (same principle as for mean TL of catch). “Lifespan” is a measure of ecosystem stability and resistance to perturbations and is used to measure state and trend.

**1/Coefficient of variation of total biomass** reflects the stability of the ecosystem, and is measured as the inverse of the coefficient of variation (CV) over the last 10 years. As with “fishing pressure”, it is expressed as an inverse to make it conform with the directionality of the other indicators. Thus a low 1/CV indicates low “biomass stability”. Since this indicator is measured over a 10-year period, it is only used to measure state.

**Species considered in the calculation of indicators**

**Surveyed species**

These are species sampled by researchers during routine surveys (as opposed to species sampled in catches by fishing vessels), and include species of demersal and pelagic fish (bony and cartilaginous, small and large), as well as commercially important invertebrates (squids, crabs, shrimps...). Intertidal and subtidal crustaceans and molluscs such as abalones and mussels, mammalian and avian top predators, and turtles, are excluded. Surveyed species are those that are considered by default in the calculation of all survey-based indicators.

**Retained species (landed)**

These are species caught in fishing operations, although not necessarily targeted by a fishery (i.e. include bycatch species), and which are retained because they are of commercial interest, i.e. not discarded once caught, although this does not imply that sometimes certain size classes of that species may be discarded. A non-retained species is considered to be one that would never be retained for consumptive purposes. Intertidal and subtidal crustaceans and molluscs such as abalones and mussels are to excluded. Retained species are those that are considered by default in the calculation of all catch-based indicators.

**Predatory fish species**

Predatory fish are considered to be all surveyed fish species that are not largely planktivorous (i.e. phytoplankton and zooplankton feeders should be excluded). A fish species is classified as predatory if it is piscivorous, or if it feeds on invertebrates
that are larger than the macrozooplankton category (> 2 cm). Detritivores are not classified as predatory fish.

Environmental indicators

**SST, Sea Surface Temperature**

Sea surface temperature (SST) is associated with variations in the rate of growth and metabolism and the distribution and survival of exploited fish, their predators and prey. SST forms an important climatic variable to monitor given its influence on bottom-up and top-down processes which affect the productivity of fish populations and our ability to survey them. SST values derived from the standard 4km Pathfinder v5.2 AVHRR satellite sensor data are shown to highlight differences between systems.

**Chl a, Chlorophyll a, the concentration of the main phytoplankton pigment in surface waters**

Chlorophyll a (Chl a) is associated with the biomass of phytoplankton which either directly or indirectly supports all life stages of exploited fish species. High mean Chl a (e.g. > 1 mg Chl a/m³) are generally associated with productive ecosystems which have ample access to nutrients and light, whereas low mean Chl a concentrations imply that the availability of phytoplankton resources to support fisheries may be limited. The availability of phytoplankton resources has the potential to affect the productivity of fish populations and their distribution, consequently Chl a forms an important environmental variable to monitor. Mean surface Chl a values (derived from the application of the standard Case 1 water algorithm OC3M product to 4 km MODIS Aqua spectral data) are shown to highlight potential productivity differences between systems.

**Human Dimension indicators**

1) Effectiveness and efficiency of fisheries management
2) Quality of governance
3) Contribution of fisheries to broader society
4) Wellbeing and resilience of fisher communities

1. **Effectiveness and efficiency of fisheries management** refers to how well fisheries are managed in the ecosystem. It measures how frequently stock assessments are carried out, whether reference points are used, whether there is an attempt to rebuild depleted stocks, the frequency with which management measures are reviewed, whether ecosystem impacts are considered in the assessment, and whether illegal fishing is controlled.

2. **Quality of governance** is a measure of how well the ecosystem is being governed. Governance is fundamental to fisheries, determining the manner in which power and influence are exercised over the management of fisheries resources. We provide a measure of whether the fishery is managed to reduce conflict, whether there are long-term management objectives, whether these include social and economic considerations, and whether participation of the harvesting sector is a requirement in fisheries management.

We rely on expert knowledge to provide the information required for the indicators of these first two sub-goals. A questionnaire was developed and completed by the relevant experts from the IndiSeas ecosystems. The questions were designed to be objective and experts were asked to provide evidence in support of their response. A
score of 1-5 (poor to good) was used for each question and the responses were averaged to provide indicators of “Effectiveness and efficiency of fisheries management” and “Quality of governance”.

3. Contribution of fisheries to broader society is a measure of the overall benefits that fisheries can bring to the wider society. Here we use measures of the economic and social contributions of fisheries to society, including the contribution of fisheries to food security.

4. Wellbeing and resilience of fisher communities: wellbeing essentially refers to living standards of fishers (materially, in terms of their relations with others, and their perception of quality of life) and resilience is the ability of fisher communities to respond to, and recover from change. These are both complex concepts and here we have used simple measures of economic viability (wellbeing) and opportunity to diversify (resilience).

Selection criteria

- **Theoretical basis**: indicators should reflect well-defined ecological, social or economic processes underlying fishing activity.
  
  The ecological and human dimension indicators should rely on strong scientific and theoretical knowledge of the links between exploited marine communities, human communities and fishing pressure.

  Environmental indicators should reflect biological or physical processes that are important drivers of production and condition of the exploited resources.

- **Sensitivity**: ecological and human dimension indicators should be able to track changes attributable to fishing pressure.

  Trends in the indicators need to be highly responsive to fishing pressure and their interpretation non-ambivalent.

- **Measurability**: indicators need to be measurable or estimated on a routine basis, and historical data time-series must be available across the broad spectrum of exploited marine ecosystems under comparison.

- **Tractability**: the set of indicators must remain tractable, i.e. small. It must permit synthesis of the states and trends of exploited ecosystems, and it must be possible to estimate the set of indicators (i) for an extended range of ecosystems, (ii) with annual updates. Redundancy of indicators should be avoided as much as possible.

- **General public awareness**: the meaning of the indicator and its link with fishing needs to be widely and intuitively understood.