

Proposal for a SCOR Working Group on

"Evaluating the ecological status of the world's fished marine ecosystems"

Abstract

There has been a strong move worldwide towards the Ecosystem Approach to Fisheries (EAF). To make progress towards implementing the EAF, carefully selected and appropriate indicators are required to translate ecosystem impacts and changes into management measures that can be assessed for their effectiveness. The scientific community grappling with the EAF is challenged to provide a generic set of integrated ecological indicators to accurately reflect the effects of fisheries on marine ecosystems, to facilitate effective communication of these effects to the public and policymakers, and to promote sound management practices. Building on the work of SCOR/IOC Working Group 119 on "Quantitative Ecosystem Indicators" (2001-2004), this proposal of a SCOR WG "Evaluating the status of the world's fished marine ecosystems" aims at applying the concepts and theories developed previously to set up concrete worldwide applications: review of a minimal set of ecological indicators to assess fishing effects, consolidation and review of available data across world marine ecosystem's, comparative analyses of the exploitation status of world's marine ecosystems, transfer of scientific knowledge to the general public and stakeholders through the delivery of a publicly accessible website, building bridges with other research fields (sociology, economics, climate change, biodiversity/conservation) to promote an integrative ecosystem approach to marine resources.

Background and Rationale

Societal and scientific background

After decades focusing on the study and management of single species, fisheries management is evolving towards ecosystem-based approaches. These regard the ecosystem as the most relevant unit for management, emphasising that resilient ecosystems are crucial to maintain the sustainability of marine goods and services. Efforts are now being made to measure and alleviate the ecosystem effects of fishing (Hall 1999) and focus is very much on how an ecosystem approach to fisheries may be implemented (Garcia and Cochrane 2005). The FAO Reykjavik declaration of 2001, reinforced at the World Summit on Sustainable Development in Johannesburg in 2002, requires nations to develop and start implementing an Ecosystem Approach to Fisheries (EAF) for reconciling conservation and exploitation objectives by the year 2010. Nations are further required to restore depleted fish stocks by 2015, and to establish representative networks of Marine Protected Areas by 2012.

To fulfill these objectives, a strategy based on innovative and integrated science is urgently needed to translate the complexity of marine ecosystems into comprehensible signals and to propose operational management frameworks (e.g. FAO 2003, Link 2005). The scientific community is therefore challenged to provide a generic set of integrated ecological indicators to accurately reflect the effects of fisheries on marine ecosystems, to facilitate effective communication of these effects and to promote sound management practices.

The groundwork has been established by the SCOR/IOC WG 119 (Cury and Christensen 2005) which reviewed the relevance of a wide range of ecological indicators according to the following criteria:

- ecological significance (i.e. are the underlying processes essential to the understanding of the functioning and the structure of marine and aquatic ecosystems?)
- measurability: availability of the data required for calculating the indicators
- sensitivity to fishing pressure
- awareness of the general public.

It also provided some of the ecological background to understand which processes and fishing effects are captured by ecosystem indicators. This review categorised ecosystem indicators into three main types: size-based (Shin et al. 2005), trophodynamic (Cury et al. 2005) and species-based indicators.

What is now needed to implement EAF worldwide is a concrete framework to facilitate the application of ecosystem indicators as a tool for diagnosing the ecological state of the world's marine ecosystems and subsequently as a means of initiating appropriate fisheries management responses that would address and alleviate the impacts of fishing on ecosystems.

Objectives

The goal of this proposed working group "Evaluating the ecological status of the world's fished marine ecosystems" is to develop a concrete framework for the application of ecosystem indicators to assess ecosystem state and develop management guidelines using a comparative approach. Specifically we propose to (i) publicly launch a generic dashboard of ecosystem indicators using a common set of interpretation and visualisation methods and populate it with data from diverse marine ecosystems around the world, (ii) test the performance of indicators and develop reference points, (iii) add climate, socio-economic and biodiversity/conservation indicators to a set of integrative ecological indicators developed during Eur-Oceans meetings (see below), and (iv) evaluate the exploitation state of marine ecosystems in a comparative framework from all three tiers of an EAF (ecological, social, economic).

The most concrete initial deliverable of this Working Group is the creation of a website informing the public at large, as well as scientists, about the impacts of fishing on the state of world's marine ecosystems. Communication is widely recognised as key to successful EAF (Degnbol 2005). A common protocol for interpreting, representing and communicating a carefully selected suite of indicators needs to be established for a wide range of ecosystems. This will require development and adoption of generic syntheses of indicators to represent adequately and simply the state of an ecosystem. The syntheses will be graphic (use of colors, graphics etc), will necessitate the adoption of common statistical methods within the working group for standardising indicators, interpreting combined sets of indicators, interpreting the trends in indicators, and transforming quantitative information into semi-quantitative and qualitative information in a multidisciplinary framework.

The following questions will be addressed by the WG:

- How should ecological indicators be interpreted and scientific knowledge be best integrated?
- How should ecological indicators be analysed for moving towards ecosystem diagnosis and formulating recommendations for management purposes?
- Which indicators should be used to synthesize and communicate ecosystem status in terms of climatic change, socio-economics and biodiversity/conservation?
- How can we compare the status of exploited marine ecosystems?
- How can the knowledge gained from indicators be best represented and communicated to decision-makers and the general public?

There are several reasons why a comparative approach is adopted in this WG:

- With the difficulty in establishing baseline levels and reference points for most ecosystem indicators, the comparative approach across ecosystems will provide a range of reference values against which each ecosystem can be assessed;
- The comparative approach will also help in selecting robust ecological indicators that will be meaningful and measurable over a set of diverse and contrasted situations;
- The comparative approach between ecosystems, together with the communication of results to the public at large are also aimed at creating an incentive for politicians to consider their management options, with informed responsibility for the ecological, social and economic quality of marine world ecosystems.

Timeliness and relevance to other international activities

The proposed WG will greatly benefit from the advances made by the previous SCOR/IOC WG 119 in 2001-2004. While SCOR/IOC WG 119 focused on theoretical and conceptual studies, the selection of relevant ecological indicators and on local empirical studies, the present proposed WG will focus on the concrete application of indicators to the diagnosis of marine ecosystems, on a global evaluation of marine ecosystems, and on the transfer of knowledge to the general public and to stakeholders. This is seen as a substantial step towards implementation of an Ecosystem Approach to Fisheries. The

products of this group will be useful for any future marine assessments, such as the Global Marine Assessment.

In 2007 and 2008, the European Network of Excellence (NoE) EUR-OCEANS (www.eur-oceans.eu) supported the organization of two meetings dedicated to the first stage of a worldwide comparative approach. Yunne Shin and Lynne Shannon were co-leaders of these meetings, which facilitated clarification of the objectives of the present proposal and assembled expertise from 20 ecosystems around the world. Building on the results of the Eur-Oceans meetings and the collaborative networks that have been established as a result, we are presently ready to propose a common list of indicators to be calculated in each ecosystem, and to propose the structure of a first prototype of a website. This proposed list of indicators and prototype website will help to attract experts from other ecosystems to join the analyses, and will allow us to concentrate on the methods for establishing a diagnosis, for comparing ecosystems' status, testing indicator performance and for the expansion into other disciplinary areas (climate change, sociology, economics and biodiversity/conservation). This expansion of the initial indicator suite based on fisheries data is seen as a major challenge and highly necessary if we are to progress with EAF worldwide. Through associations with experts in these fields, the proposed SCOR WG will facilitate parallel selection and analyses of indicators from these additional disciplines.

The SCOR "label" will ensure the success of the WG as it will provide an international visibility which will attract top scientists across several fields working on a common ecosystem approach to marine resources and will ensure that the scientific analyses are undertaken with rigour and complete neutrality. This last point is critical as we aim at transferring our scientific knowledge to other spheres.

The comparative approach is global in its focus so we plan to extend our initial network to other ecosystems in the world, and a SCOR WG provides this capacity of community building. Finally, we also plan to build bridges with other research fields (socio-economics and climate change) so again, having the visibility of SCOR will greatly facilitate conducting inter-disciplinary studies.

Additional sources of funding are already identified: IRD (Institut de Recherche pour le Développement) and the European project MEECE (2008-2012, www.meece.eu) will provide the persons-month necessary to develop the website. We also contacted AIRD (Agence Inter-établissements de Recherche pour le Développement) to request funding the travel expenses of scientists from developing countries, and we plan to contact FAO.

Terms of reference

The proposed working group would work towards:

- 1. Defining a common protocol using ecosystem indicators for elaborating a diagnosis of the exploitation state of marine ecosystems.** This stage involves the development and selection of adequate statistical methods for characterizing trends in indicators (autocorrelated regression, GAMs, first and second-order derivatives), for detecting similarities between indicators (PCA analyses, mutual information index) and for establishing a classification of marine ecosystems according to fishing impacts (decision tree analysis, scoring and ranking ecosystems).
- 2. Developing a common, generic visualisation and communication tool for synthesizing the exploitation status of marine ecosystems.** A website will be developed, aiming at documenting the exploitation status of world's marine ecosystems and communicating scientific results to the general public and stakeholders.
- 3. Testing the performance of ecosystem indicators in fisheries management.** How do we know that ecosystem indicators can walk to talk, that is, how do we know how well an indicator indicates and guides management decisions? This is a crucial question in the development of indicators and is often ignored. Performance testing is a formal procedure to assess whether an indicator and accompanying decision rule actually guides decision-makers to make the "right" decision. Performance testing scores the ratio of "right" decisions to "wrong" decisions. The suite

of indicators collected under the EUR-OCEANS initiative provides a unique opportunity to test these indicators across a range of ecosystem types. Conclusions should be very robust.

4. **Developing reference points for indicators.** Establishing reference points for ecosystem indicators has proven to be a major challenge to implementing EAF, due to the complexity of ecosystems and their response to fishing. A key benefit of the comparative approach proposed for this SCOR WG is that it provides empirical data on ecosystem indicator behaviour across a range of ecosystem types and states. These data will be used to explore whether, minimally, limit thresholds can be identified, and whether possible target reference points can be proposed.
5. **Building bridges with other scientific fields to assess the usefulness of the set of selected ecological indicators and to complete the diagnosis by providing additional non-ecological indicators.** This will provide a more integrative evaluation of ecosystems states to support an ecosystem-based fisheries management. Three specific tasks will be addressed:

5.1- studying the joint effects of climate and fishing changes on the selected indicators. Time-series analyses will be undertaken of fishing effort and regional climate indices. Ecosystem models will also be used to assess the specificity of ecosystem indicators to fishing effects versus climate effects: EwE, Osmose and Atlantis models will be used in this regard.

5.2- integrating conservation and biodiversity issues in the diagnosis of ecosystem states. Biodiversity is a key ingredient for resilient, robust ecosystems. All too often however, species, habitats or even whole ecosystems are negatively affected by fishing and mitigation approaches are necessary in addition to avoiding damage through wise management. We plan to add a set of indicators that will quantify the biodiversity and conservation risks in ecosystems.

5.3- integrating socio-economic issues
EAF has many facets, and one which is too often ignored is the realm of socio-economic indicators of the effects of fishing on ecosystems. As yet, the development of socio-economic indicators lags that of ecological indicators, and thus there is less to work with. However, we aim to review existing socio-economic indicators then apply the criteria outlined above to select a subset of socio-economic indicators for inclusion in the generic dashboard of indicators.

Planned activities and Products

If the SCOR proposal is successful, the first steps will be to set up 5 task groups to address each of the TORs and to plan for three annual meetings.

All terms of reference will be addressed at each of the annual meetings. However, the main emphasis of meeting 2 will be on TORs 2 and 4, and the main emphasis of meeting 3 will be on TOR 5. It is proposed that the first annual meeting takes place in Sète (IRD-CRH) or potentially back-to-back with the GLOBEC Third Open Science Meeting in Victoria (June 2009, Canada).

We propose the WG to have 3 co-leaders, Yunne-Jai Shin, Alida Bundy and Lynne Shannon. In addition to assuming current coordination tasks (delivering annual reports, searching for additional fundings, distributing documents and data to each participant, organizing annual meetings, coordinating activities between meetings), each co-leader of the WG would assume the main responsibility of each of the following deliverables and for TORs as indicated.

- Yunne-Jai Shin (TORs 1,2,3,5.1) will be responsible for the delivery of the **website** dedicated to inform the general public about world's marine ecosystems. We have already booked the website address www.indiseas.org which will be accessible to the general public and stakeholders. Based on the two Eur-Oceans meetings that occurred in 2007 and 2008, we can ensure that at least 14 marine ecosystems will be fully documented during the first year of the SCOR WG. The website will be made accessible from the first year (2009) of the WG to provide international visibility and to attract more scientists to contribute to enriching the website with their ecosystem data and syntheses. The objective is to provide a broad geographical coverage by the end of the WG.

- Alida Bundy (TORs 1,3,4,5.3) will be responsible for the organization of an **international symposium** at the end of the WG (2012). It will be the opportunity for the worldwide network to present their results on the use of ecosystem indicators in diagnosing ecosystems' states and implementation of Ecosystem-based fisheries management.

- Lynne Shannon (TORs 1,3,4,5.2) will be responsible for the edition of a **special Journal issue** following the international symposium (2012).

Working Group Composition

The composition of the WG is necessarily international in accordance with the objectives of the WG, which is comparative in nature. Participation by an expert from each ecosystem is a pre-requisite for adequate comparative analyses and proper scientific guidance in each ecosystem. With the proposed list of members, at least 22 marine ecosystems will be considered from the first year of the WG. All scientists proposed have comprehensive, expert knowledge of ecosystem functioning and the ecosystem approach to fisheries. The WG also includes scientists having expertise in socio-economic, biodiversity and climate indicators. The geographical coverage ensures that each type of ecosystem is well represented, as well as three major oceans (Pacific, Atlantic, Indian oceans). Among the Full Members, the group has 3 scientists from developing countries and 7 women, providing good geographic and gender balance. Additional breadth will be achieved through Associate Members.

Full members

Name	Country	Institution	Expertise	
			ecosystem	indicators
Yunne-Jai Shin, co-chair	France	IRD	upwelling	size-based
Alida Bundy, co-chair	Canada	DFO	temperate	trophodynamic
Lynne Shannon, co-chair	South Africa	MCM	upwelling	trophodynamic
Ratana Chuenpagdee	Thailand	CDC	tropical	socio-economic
Marta Coll	Spain	ICM/CSIC	temperate	trophodynamic
Erich Diaz	Peru	IMARPE	upwelling	fisheries
Nick Dulvy	Canada	SFU	temperate	biodiversity
Beth Fulton	Australia	CSIRO	temperate	fisheries
Jason Link	US	NOAA	temperate	climate
Verena Trenkel	France	IFREMER	temperate	fisheries

Associate members

Name	Country	Institution	Expertise	
			ecosystem	indicators
Vera Agostini	US	Nature Conservancy	upwelling	biodiversity
Kerim Aydin	US	AFSC	high latitude	climate
Julia Blanchard	UK	CEFAS	temperate	size-based
Fatima Borges	Portugal	IPIMAR	upwelling	fisheries
John Cotter	UK	CEFAS	temperate	fisheries
Philippe Cury	France	IRD	upwelling	trophodynamic
Ibrahima Diallo	Guinea	CNSHB	tropical	fisheries

Sheila Heymans	Scotland	SAMS	temperate	biodiversity
Louize Hill	Portugal	IPIMAR	upwelling	biodiversity
Astrid Jarre	South Africa	UCT	upwelling	socio-economic
Edda Johannesen	Norway	IMR	high latitude	fisheries
Didier Jouffre	France	IRD	tropical	biodiversity
Pierre Labrosse	Mauritania	IMROP	tropical	socio-economic
Jae-Bong Lee	Korea	NFRDI	temperate	fisheries
Steve Mackinson	UK	CEFAS	temperate	climate
Hicham Masski	Morocco	INRH	upwelling	fisheries
Christian Möllmann	Germany	U Hamburg	temperate	climate
Sergio Neira	Chile	U Concepcion	upwelling	trophodynamic
Henn Ojaveer	Estonia	EMI	temperate	fisheries
Khairdine Ould MA	Mauritania	IMROP	tropical	fisheries
Ian Perry	Canada	DFO	temperate	fisheries, climate
Jake Rice	Canada	DFO	temperate	fisheries
Marie-Joëlle Rochet	France	IFREMER	temperate	size-based
Djiga Thiao	Senegal	CRODT	tropical	fisheries
Dawit Yemane	South Africa	MCM	upwelling	biodiversity

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