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Report of the Workshop on Regional Seas Commissions and Integrated Ecosystem Assessment Scoping

17–20 November 2014

ICES Headquarters, Denmark

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

International Council for the Exploration of the Sea
Conseil International pour l'Exploration de la Mer

H. C. Andersens Boulevard 44–46
DK-1553 Copenhagen V
Denmark
Telephone (+45) 33 38 67 00
Telefax (+45) 33 93 42 15
www.ices.dk
info@ices.dk

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Executive Summary

The Workshop on Regional Seas Commissions and Integrated Ecosystem Assessment Scoping (WKRISCO) had two objectives: to summarize progress made across the ICES integrated ecosystem assessment (IEA) groups and to scope with OSPAR and HELCOM on the knowledge and information needs for upcoming regional assessments. WKRISCO provided a panorama of the work of the ICES IEA groups.

WKRISCO was held over 4 days with 26 participants. All ICES integrated ecosystem assessment groups contributed and Chairs from five of the groups attended in person. Representatives of the HELCOM and OSPAR secretariats and the European Environment Agency (EEA) participated. WKRISCO took place in two phases; the first synthesized the work of the IEA groups and considered how to explore governance and social issues. The second focused on a scoping exercise between ICES and RSCs.

The IEA groups highlighted:

i. The methods being developed and the key gaps and needs.
ii. Any prioritization of objectives and use of case studies.
iii. Their considerations about key data/quality assurance issues.
iv. The challenges associated with the governance and management context.

The report documents the commonalities and differences across ICES IEA groups (linked to challenges and opportunities), and the issues around the governance and legal context in the development of IEA methods in the ICES area. It explores uncertainty, credibility and legitimacy when making qualitative decisions and the knowledge requirements for the ecosystem approach of OSPAR and HELCOM. It is clear that both OSPAR and HELCOM are keen to engage with the IEA process.

There are differences in the priorities, objectives, and available expertise between the ICES IEA groups. WKRISCO felt that this diversity was important and reflected regional approaches, priorities and available expertise. There are few tangible demonstration cases as yet. The challenge is to how to operationalize methods and work towards demonstration advice on IEAs. IEAs should have a clear connection with marine governance structures in an ecoregion. Interaction between natural and social scientists on social drivers, impacts and ecosystem services is still considered relative novel. The inclusion of social scientists (e.g. from economics, political science, sociology or history) needs to be considered regionally. The issue of quality assurance of data supply and transparency of decision-making is only just beginning to be addressed. Researchers are aware of the challenges brought about by the differences in scales and resolutions of processes within each field of research. Suggested guidance for future IEA work in ICES is provided.

When exploring IEAs in future, researchers should ask themselves:

- What is the problem you want to solve?
- What resources are available?
- Who are the actors and what are their roles?
- What is an IEA in this context?

Preface:

Ecosystem Approach (UN, 2010) "*While there is no single internationally agreed-upon ecosystem approach or definition of an "ecosystem approach", the concept is generally understood to encompass the management of human activities, based on the best understanding of the ecological interactions and processes, so as to ensure that ecosystems structure and functions are sustained for the benefit of present and future generations. The concept builds on a number of existing tools and approaches, such as integrated coastal and ocean management, with greater emphasis on ecosystem goals and objectives.*"

http://www.un.org/depts/los/ecosystem_approaches/ecosystem_approaches.htm

Introduction

There were two main objectives for the Workshop on Regional Seas Commissions and Integrated Ecosystem Assessment Scoping (WKRISCO):

i. to summarize progress made and methods used across the ICES integrated ecosystem assessment (IEA) groups;

ii. to scope with OSPAR and HELCOM the knowledge and information needs for upcoming regional assessments (QSR and HOLAS II).

The workshop also considered how to explore the factors impacting Integrated Ecosystem Assessments (IEAs) from the governance of regional seas. The aim of the workshop was to provide the ICES IEA groups with a panorama of their work across the scope of regional seas commissions (RSC) activities (see terms of reference in Annex 1). The workshop was intended to provide a forum to explore a timeline for IEA work, in response to the scoping exercise. WKRISCO was seen as a key strategic development by ICES that will help the IEA groups to position their work in a broader context and increase their visibility in the system.

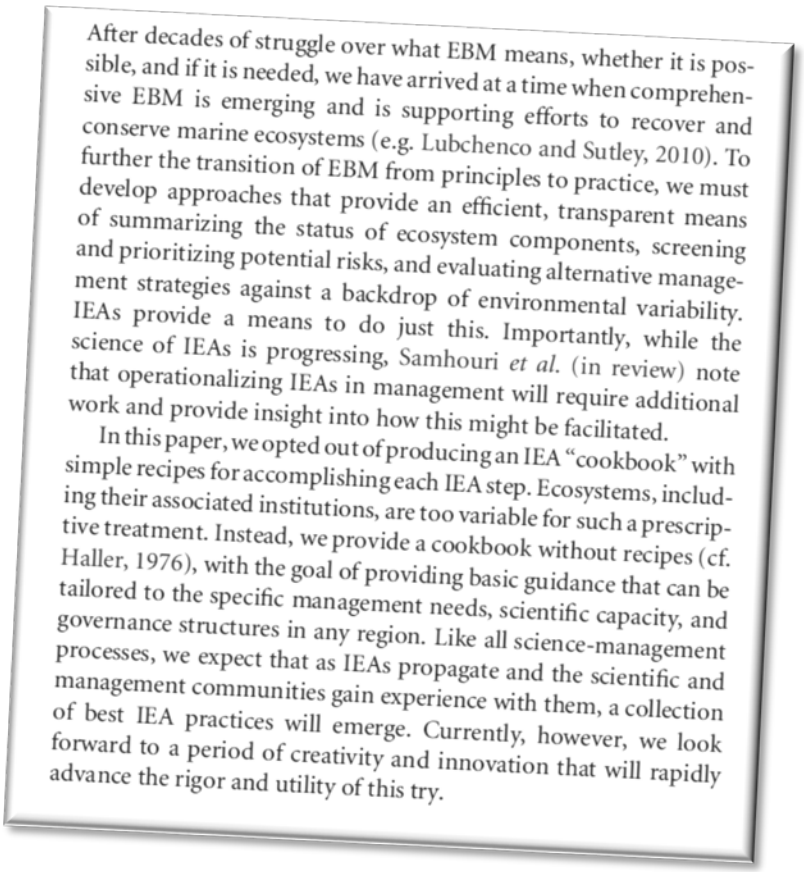
The workshop was held over 4 days (17-20 November 2014) with 26 participants (including 4 by correspondence, see Annex 3). All ICES integrated ecosystem assessment groups submitted presentations and information to the workshop (WGIAB[1], WGINOSE[2], WGINOR[3], WGIBAR[4], WGNARS[5], WGEAWESS[6], WGCOMEDA[7], Figure 1) and Chairs from five of the groups attended in person. Representatives of the HELCOM and OSPAR secretariats participated in the meeting, as did researchers from the European Environment Agency (EEA).

Figure 1. The regions covered by ICES IEA groups (WGIAB, WGINOSE, WGINOR, WGIBAR, WGNARS, WGEAWESS, WGCOMEDA)

[1] WGIAB: ICES/HELCOM Working Group on Integrated Assessments of the Baltic Sea
[2] WGINOSE: Working Group on Integrated Assessments of the North Sea
[3] WGINOR: Working Group on the Integrated Assessments of the Norwegian Sea
[4] WGIBAR: Working Group on the Integrated Assessments of the Barents Sea
[5] WGNARS: Working Group on the Northwest Atlantic Regional Sea
[6] WGEAWESS: Working Group on Ecosystem Assessment of Western European Shelf Seas
[7] WGCIOMEDA: Working Group on Comparative Analyses between European Atlantic and Mediterranean marine ecosystems to move towards an Ecosystem-based Approach to Fisheries

This report will not focus on the history and previous development of IEA approaches and methods, as this was done during WKBEMIA (ICES 2013a). The "Levin" approach was supported by WKBEMIA and is further expanded in Levin *et al.,* (2014). The setting of IEA approaches in ICES has been recently documented and explored in Walther and Möllmann (2014) and Dickey-Collas (2014). An overview of IEA approach is given in Link and Browman (2014). A further overview can be found on the ICES slide share site, where Phil Levin's keynote presentation to the ICES ASC is available:

http://www.slideshare.net/ICES_ASC/ices-asc-plenary-lecture-integrated-science-for-integrated-management-fairy-tale-or-finally-here



After decades of struggle over what EBM means, whether it is possible, and if it is needed, we have arrived at a time when comprehensive EBM is emerging and is supporting efforts to recover and conserve marine ecosystems (e.g. Lubchenco and Sutley, 2010). To further the transition of EBM from principles to practice, we must develop approaches that provide an efficient, transparent means of summarizing the status of ecosystem components, screening and prioritizing potential risks, and evaluating alternative management strategies against a backdrop of environmental variability. IEAs provide a means to do just this. Importantly, while the science of IEAs is progressing, Samhouri *et al.* (in review) note that operationalizing IEAs in management will require additional work and provide insight into how this might be facilitated.

In this paper, we opted out of producing an IEA "cookbook" with simple recipes for accomplishing each IEA step. Ecosystems, including their associated institutions, are too variable for such a prescriptive treatment. Instead, we provide a cookbook without recipes (cf. Haller, 1976), with the goal of providing basic guidance that can be tailored to the specific management needs, scientific capacity, and governance structures in any region. Like all science-management processes, we expect that as IEAs propagate and the scientific and management communities gain experience with them, a collection of best IEA practices will emerge. Currently, however, we look forward to a period of creativity and innovation that will rapidly advance the rigor and utility of this try.

Levin *et al.,* 2014

1 Methods and approach used

The workshop took place in two phases; the first 2 days synthesized the work of the IEA groups (similarities and differences) and considered how to explore governance and social issues. The following 2 days focused on a scoping exercise between ICES and the RSCs (Annex 2).

The workshop used presentations, open plenaries and subgroups throughout the four days. The approach of the first two days was to focus on "internal" ICES aspects and the latter two days looked outwards and listen to the partners of ICES in the exploration of methods for regional assessments and the ecosystem approach as a whole.

The internal ICES IEA consideration was stimulated by the following issues:

i. What are the methods being developed across the IEA groups and what are the key gaps and needs?
ii. Do the IEA groups carry out prioritization and do they use case studies?
iii. What are the key data/quality assurance issues?
iv. What are challenges caused by considering the governance and management context for the development of IEAs?

Each IEA group was asked prior to the meeting to prepare a short 10 minute presentation addressing these issues (see Annex 4). These were shown on the first day and used for the review. The workshop also received a presentation from the DEVOTES project.

The outward consideration was stimulated by the research and development needs of OSPAR as it considers the ecosystem approach, by HELCOM as it looks toward HOLAS II, by the future reviews of management plans by Norway and the needs of the EEA for assessing Europe wide indicators of marine Good Environmental Status (GES).

The first two days used the chairs of subgroups to summarize findings whereas during the latter two days, this was supplemented by a written record of the meeting.

Figure 2. Darius Campbell (OSPAR), Jörn Schmidt (ICES) and Ulla Li Zweifel (HELCOM) consider the knowledge needs for regional sea assessments at WKRISCO.

2 Commonalities and differences across ICES IEA groups

All ICES IEA groups provided input to the review and synthesis (Term of Reference a). Their presentations and submissions are available on the WKRISCO SharePoint site.

2.1 Commonalities

The leading commonality was the energy and dedication of the teams of scientists working across the IEA groups in ICES.

Time-series data analysis

Time-series of ecosystem indicator data are central to the ICES IEA activities. Analyses of these can include integrated trend analysis, GAM/GLM and other methods. The aim of these is to increase knowledge and understanding of the processes that have created the current time-series of observations. They can be used to identify interrelationships, key ecosystem trends and suggest indicators which can inform management. They also can be used to identify the regime shifts and transitions, as well as the ecosystem indicators states that are incompatible with management objectives.

Ecosystem Overviews

These descriptions of the regional ecosystems have been developed to support advice, in the context of pressure/state relationships (see WKECOVER[8] and WKDECOVER[9]; ICES 2013b, c). The information in the ecosystem overviews comes from a range of sources (Table 1). Most IEA groups are now feeding input into these Ecosystem Overviews and they are seen as valuable to get a general overview of the ecosystem (Table 2). They should be updated when appropriate. It should further be explored how to feed the indicator work described above into this framework to be more specific and better inform assessments and advice.

Methods to consider management choices and risk analysis

Various IEA groups are developing approaches for examining management scenarios. These methods often require combining quantitative approaches with qualitative approaches and often incorporate expert judgement (Bayesian belief networks, Bayesian network models, ODEMM approach).

Ecological Risk Evaluation can identify the most important sectors, pressures, and ecosystem components to focus the analysis. Risk evaluation should also include the risk of not achieving management targets. Risk evaluation can also form part of scoping within an IEA.

Considering social and economic drivers and impacts

All groups reported considerable challenges when considering social and economic drivers and impacts. Some groups did not see this kind of work as within their remit.

[8] WKECOVER: Working Group on the ICES ACOM/SCICOM Workshop on Ecosystem Overviews
[9] WKDECOVER: Workshop to draft Advice on Ecosystem Overviews

Others were trying to incorporate this field into their analysis but reported that they were making slow progress.

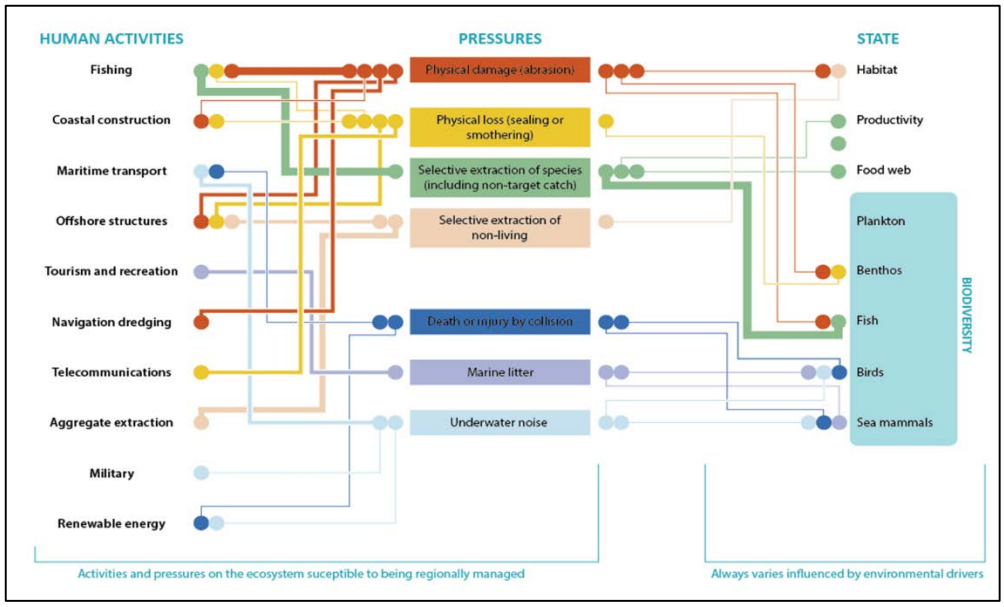


Figure 3. Example of Ecosystem Overview summary output from the Greater North Sea.

Region and subregion

All groups reported that they had subdivided their respective regions. They had either chosen specific areas as case studies (e.g. WGNARS and WGINOSE) or were working on approaches in many different subregions (e.g. WGEAWESS, WGIAB). Only WGINOR and WGIBAR were considering the entirety of their ecoregion within their analysis.

Data, knowledge and quality assurance issues

Few groups had focused on the issue of data/quality assurance issues. Most groups were using "semi-informal" mechanisms for data provision and documentation of methods. At the workshop all participants saw this issue as important but commented that so far it had not been central to their considerations.

2.2 Differences across the IEA groups

The following differences were apparent across the IEA groups

- Overall objectives of the groups;
- Regional governance structures in the ecoregions;
- Sectors being considered within the analysis of the groups;
- Information base available for any analysis;
- Ecosystem structure and function (e.g. coastal, embayed, oceanic);
- Life time of the groups, from 8 years of meetings to under a year;
- Expertise available to the groups;
- Experience of working with social scientists (e.g. from economics, political science, sociology or history).

Many of these factors resulted in differences in the analytical methods and tools being developed by the groups. Whereas some groups were considering climate change, and others were not, it was clear that variability of the productivity and function of the ecosystem was a key issue that needed to be considered when exploring future management scenarios.

WKRISCO agreed that this diversity across the ICES IEA groups was one of the benefits of the ICES initiatives. As all groups were designed to develop and explore potential methods relevant to their challenges, this diversity would most likely lead to a greater portfolio of available approaches. However, once IEAs become more operational, there may be a need to increase the degree of quality assured methods applied during IEAs. This latter step of operationalization has neither been deeply discussed nor exists as a framework and is considered high priority to fulfil the ICES strategic plan and its implementation.

Table 1. Sources of Information used for the Ecosystem Overviews (EO)

Sources of information
National MSFD initial assessments
OSPAR reports
HELCOM reports
Environmental assessments
ODEMM project
WG reports: WGIAB, WGINOSE, WGEAWESS

Ecosystem Approach (FAO 2002): *"An ecosystem approach … strives to balance diverse societal objectives, by taking in-to account the knowledge and uncertainties about biotic, abiotic and human components of ecosystems and their interactions and applying an integrated approach … within ecologically meaningful boundaries."*

http://www.fao.org/fishery/topic/13261/en

Table 2. ICES Working Groups engaged in the development of the Ecosystem Overviews (EO).

Group name	Acronym	Section EOs	date	Other
WG on Ecosystem Effects of Fishing Activities	WGECO		2013-14	Strategy and review of framework
Workshop on Ecosystem Overviews	WKECOVER		2013	Outline template and concept
Workshop to draft Advice on Ecosystem Overviews	WKDECOVER	Description Key signals Pressures	2013	Draft EOs for BoB, NSea, CSea and partially for BSea
WG on Integrated Assessments of the North Sea	WGINOSE	Description Key signals Pressures	2013-14	WG report: preliminary EOs by IEA groups
WG on Ecosystem Assessment of Western European Shelf Seas	WGEAWESS	Description Key signals Pressures	2013-14	WG report: preliminary EOs by IEA groups
ICES/HELCOM WG on Integrated Assessments of the Baltic Sea	WGIAB	Description Key signals Pressures	2013-14	WG report: preliminary EOs by IEA groups
Work planned for 2015				
Working Group on the Integrated Assessments of the Norwegian Sea	WGINOR	Description Key signals Pressures	2015	EOs drafted in subgroup and reviewed by WGINOR
Integrated Assessments of the Barents Sea	WGIBAR	Description Key signals Pressures	2015	EOs drafted in subgroup and reviewed by WGIBAR
Work planned for 2015 for section 4 on STATE of ecosystem components				
Benthos Ecology WG	BEWG	State: Benthic habitat	2015	
WG on Small Pelagic Fishes, their Ecosystems and Climate Impact	WGSPEC	State: Pelagic Habitat	2015	
WG on Phytoplankton and Microbial Ecology	WGPME	State: Pelagic Productivity	2015	
WG on Multispecies Assessment Methods	WGSAM	State: Foodweb structure	2015	
WG on Zooplankton Ecology	WGZE	State: Zooplankton	2015	
Benthos Ecology WG	BEWG	State: Benthos	2015	
WG on Cephalopod Biology and Life History	WGCEPH	State: Pelagic Invertebrates	2015	
Joint ICES OSPAR WG on seabirds	JWGBIRD	State: Birds	2015	
WG on Marine Mammal Ecology	WGMME	State: Mammals	2015	
WG on Introduction and transfers of Marine Organisms	WGITMO	State: Invasive species	2015	

3 Challenges and Opportunities for ICES IEA groups in the near future

> *"IEA stands for an Integrated Ecosystem Assessment, not an Exhaustive Ecosystem Assessment"* Marie-Joëlle Rochet, A Coruña, September 2014.

The main challenge for the IEA groups is also one of the main strengths: all operate in very different ways towards integrated ecosystem assessments, which offers opportunities for methodological exchange. Differences in approaches are mainly related to different self-set objectives and starting points. The different methodological approaches are also linked to different data available to the groups. All except one (WGNARS) have not yet started to incorporate social and economic sciences.

The opportunities of IEA groups within the ICES system is the possible exchange with other more topical groups, either related to specific species groups or method development. They also have the possibility to make the science relevant to society applying ecosystem understanding (inclusive of social analysis) to operational decision-making.

The sections below contain the views of the IEA working groups themselves.

3.1 WGIAB

The main opportunity for the Working Group for Integrated Assessment of the Baltic Sea (WGIAB) is its basis in a scientific network. Many WGIAB members are active in international research projects to develop ecosystem-based management, whereas others represent management aspects and are familiar with existing management directives. The Baltic region also has relatively good data availability, although there are some data gaps. Examples are the lack of spatial overlap among dataseries on different ecosystem components, and data on temporal trends in social drivers. One analytical challenge is that the high complexity among geographical areas should always be included in the analyses, in order to make them relevant. Hence, it is desired that a large number of experts participate to represent different fields and their particular areas of expertise. Some key members have problems to participate related to funding. Also, key persons for developing fisheries-based advice within ICES are heavily involved in the regular assessment work. The strong variability among years in who will attend the meetings makes it difficult to make specific long-term terms of reference.

Given the existing opportunities and challenges, a potential way forward to support the operationalization of an ecosystem approach to management is to identify case studies/study groups dedicated to particular management issues. These would involve the relevant expertise from WGIAB and relevant ACOM-groups, or perhaps WGIAB and HELCOM. The projects/study groups can work around the year, or when possible in parallel with the WGIAB meetings. This is foreseen to permit a true integration between scientific development and advisory bodies, and support the stepwise improvement of knowledge within an adaptive ecosystem-based management framework.

3.2 WGINOSE

Challenges: after having defined the Bayesian Network structures for the southern North Sea and northern North Sea the next step for WGINOSE is to define the conditional probabilities based on the available time-series. An update of the required time-series data for the northern North Sea and southern North Sea cases has been completed by September 2014. This requires a sound explorative analysis of the correlation matrix of the respective sets of variables and Principal Component Analysis (PCA) will be applied to explore the covariance between variables. In brief, PCs will be used to represent the essential behaviour (reaction) of groups of species, for instance, leaving out details considered irrelevant to the whole system or having no clear interrelationship with the forcing parameters represented in the Bayesian Network. The use of PCs does not preclude the representation of individual species in the Bayesian Network. But PCs may act as parent nodes and interactions of individual species with (e.g. abiotic) forcing variables may all be channelled through these PCs.

Opportunities: by developing a spatial framework for the development of Bayesian Networks we are able to better identify and target the most appropriate pressure and state data to be integrated within the assessment model which matches the scale most relevant to address the management and assessment needs. Therefore a spatial framework for the development of Bayesian Network assessment tools needs to be defined, a task which WGINOSE is working towards developing.

3.3 WGINOR

Opportunities: There is a solid knowledge base in the Norwegian Sea. The monitoring, especially the international ecosystem surveys in May and July, ensures a comprehensive data foundation for ecosystem research. The Norwegian Sea stocks are mostly well managed and fishing is the dominant pressure in this ecosystem, with few other human pressures impacting. The main role of WGINOR is therefore to build on the work of the assessment WG (WGWIDE) dealing with assessment of herring, blue whiting and mackerel, and consider cumulative effects of climate and harvest on stocks and other ecosystem components, as well as stock interactions.

Challenges: The Norwegian Sea is housing a high abundance of migrants during summer, including herring, blue whiting and mackerel. The interaction between these fish stocks can be considerable and in particular they can be a key predator on herring and blue whiting larvae. Other key links are between the phytoplankton and zooplankton and fish and zooplankton. Understanding the spatial dynamics is key to understanding the ecosystem dynamics in the Norwegian Sea. There exists a budget for the flow of energy between the different ecosystem components, but this needs to be updated as part of the work within the WG. Particular attention will be given to this topic in the next period.

3.4 WGIBAR

Opportunities: There is a solid knowledge base in the Barents Sea. The monitoring, especially the joint Russian-Norwegian ecosystem survey, ensures a comprehensive data foundation for ecosystem research, with a long history of successful cooperation between the two countries through the Joint Norwegian-Russian Fisheries commission. The Barents Sea stocks are mostly well managed and fishing is the dominant pressure, with few other human pressures. The main role of WGIBAR is to therefore to expand on the work of the assessment WG (AFWG) and consider cumulative ef-

fects of climate and harvest on stocks and other ecosystem components. The two groups share key members, aiding the integration of the work and providing a route by which the IEA can influence the stock assessment and advice.

Challenges: The Barents Sea is large (ca. 1.8 million km^2), and undergoing rapid changes. Furthermore the region has the potential for increasing human activity (hydrocarbons, shipping, and alien species). The required monitoring costs are therefore large. The majority of the fisheries and research are shared between only two countries (Norway and Russia) and two institutes (IMR and PINRO). Both regular monitoring and methodological development are therefore limited by available capacity/funds, uncertainty in these factors is making long-term research planning difficult. Norwegian-Russian cooperation in environmental management is less developed than in fisheries, but the Joint Norwegian-Russian Environmental commission is working continuously to develop a functional cooperation. Within Norway there are challenges in forging cooperation between the different government agencies, and communication between WGIBAR and the Norwegian Management plan for the BS will become important in future.

3.5 WGNARS

Our primary opportunity is providing a "worked example" IEA to demonstrate how it can support decision-making in complex, multi-sector ocean management, with sufficient flexibility to be used in US and Canadian national and regional governance scales. As EBM evolves in both nations, example scientific products provide opportunities for scientists, managers, stakeholders, and policy-makers to visualize integrated management, and iteratively refine needs and objectives for assessment. Our primary scientific challenge is delivering an integrated, multiyear group product connecting conservation and human dimensions management objectives to indicators and management measures, and carrying these through a management strategy evaluation incorporating the large-scale climate drivers and multiscale regional responses of ecosystems and human systems. This analysis will be attempted in two subregions with different data, modelling, allocated time, and scientific expertise resources. Although we aim to analyse both fisheries and offshore energy (wind and hydrocarbon) development, WGNARS currently lacks expertise in offshore energy. An ongoing challenge is maintaining engagement and making the best use of available expertise at each meeting when topics range widely (and necessarily) from physical oceanography through governance. Finally, we scientists are challenged regarding how to engage policy-makers with the capability to implement stakeholder processes for IEA scoping, and ultimately to develop fully integrated cross sector, agency and country applications of EBM based on IEAs.

3.6 WGEAWESS

The main opportunity for WGEAWESS is the potential for working up ODEMM IEA analyses in a common broad format. The western shelf seas are subdivided into a number of very different ecosystems ranging from the mainly enclosed Irish Sea in the North to the Gulf of Cadiz open to the Atlantic, and southern and Mediterranean influence. Using a common framework will allow us to examine as many aspects of the sector-pressure-component linkages as possible. The ODEMM framework also allows us to evaluate without having access to substantial time-series data that match across all the subregions. Working up ODEMM IEA analyses in a common broad format requires also the availability of a meta-database to be maintained either on a subdivision basis or across subdivisions, depending of the type of pressures and in-

teractions to analyse. For example: if priority is giving to the fishing activity and the process of abrasion in the habitat, one common analysis could be mapping fishing activity in a common framework across subdivisions.

The other opportunity may be that we could have major ecosystem trends or events identified in only one subregion initially that could be checked out in neighbouring subregions, that would otherwise not have identified these. Whether these trends or events are reflected in other subregions, the information is valuable and important – local or global features.

The main challenges, not surprisingly, are also related to working in a series of quite different ecosystems. The underpinning research vital for developing IEA may have been defined in scope based on both the specifics of each ecosystem, and on national priorities. This then tends to mean that data collected in the different subregions may be very different. This can be simply that one category of data may not be collected in one subarea but will be in another. Equally, data may be collected in a given category in several subregions, but on a very different conceptual basis. A good example would be the analysis process for chlorophyll, where no agreed protocol exists.

The (quite appropriate) tendency for the local scientists to work on their local ecosystems, where they have the best knowledge base, is also a challenge to a more integrated process. It also means that the human resource available in any one subregion will be limited, and the scope for joint work across subregions will be limited. On a broader basis, the main challenge is the relatively small number of people allocated by the institutes to the WG, and for intersessional work. A major challenge is to bring the attention of the institutes to the WG, according to their common priorities on MSFD and other marine policies. The linkage with stakeholders and services to be delivered remain to be identified which precludes also a major participation in the WG.

3.7 WGCOMEDA

The main opportunity for our newly formed WG will be the possibility to work within an overarching framework investigating the functioning of two very distinct ecosystems (i.e. the Atlantic and the Mediterranean), as well as combining and contrasting within regional sea scales. As such we hope to achieve a deeper understanding of the ecological communalities and differences of these two systems and thus hope to add to the knowledge, which will be needed to adopt EMB on a regional level. As such we hope to highlight also differences of these systems to fisheries managers and policy-makers that may trigger novel inputs to adapt common policies to local/regional specificities. We hope that through our work we will be able to provide guidance on what strategies might work in both Atlantic and Mediterranean and where a more specific approach might be appropriate. Challenging for the working group will be to integrate policy and social aspects into the working groups current focus but this may change as the WG seasons over the coming years.

4 Governance and legal context in the arena of ICES IEA groups

Term of Reference b of WKRISCO was "*Provide a forward looking systems analysis across the ICES ecoregions of the governance and legal context that impact on IEAs*". This could be interpreted as understanding the governing system impacting on the ecosystem (including human use); where the governing system is the complex of actors and structures that govern. Or the term of reference could be interpreted as understanding the role of the governing actors vs. science in an IEA. An ecosystem assessment is about understanding the link between the natural system (ecosystem) and social system (human system); both of which are governed.

The workshop discussed this distinction. It explored the ideas of impacts and services in a complex, diverse and dynamic system. It explored how in an integrated ecosystem assessment there is the need for knowledge (ecological, economic and social), but also that outcomes of an assessment depend on societal visions of nature. Like other IEA proponents, this discussion led to the conclusion that scoping was an important part of IEAs and scientists need to discuss boundaries with society.

Governance systems vary across the regions with existing management plans in some areas (Norwegian Sea and Barents Sea); the EU operating in some; states, provinces and nations intersecting responsibilities (USA and Canada) and the complexities of the Mediterranean. However analytically, there are social science methods available to gain understanding of governance structures in each system. Reference was made to work undertaken in the ODEMM project to understanding the governance structure and interactive governance challenges in the EU context (Ounanian *et al.*, 2012, van Leeuwen *et al.*, 2012).

4.1 Exploring scoping

In the Levin approach, as accepted as guiding the work of the ICES IEA's, scoping is the first step. Scoping is a key governance step, as it links scientific work to society. Three key questions to be asked during scoping can be identified: what are the EBM objectives, what do you need – based on these objectives and who is affected (scoping a-c). A fourth question, that was raised was a more fundamental question, as it's answer will have serious implications for the methods used in scoping and the science needed for an IEA (scoping d). This exercise was designed by a subgroup of workshop participants (mostly social scientists and governance researchers), facilitated by Marloes Kraan and involved a range of questions.

Scoping a–What is the problem you want to solve?

What are the objectives for management of activities in the marine environment? Setting and choosing the objectives should not be under the remit of scientists. Is there a legal framework that already describes the objectives?

Scoping b– What resources are available?

Which types of knowledge do you need to fulfil an IEA to reach these goals? And what disciplines do you need? In addition, what are the limitations on resources? Is there a need to prioritize efforts? What is achievable and what does ICES want us to offer for an IEA?

Scoping c– Who are the actors and what are their roles?

Who could be interested in the outcome of an IEA? Who could be affected by the outcome of an IEA? This can be evaluated through a mapping exercise of the different actors, levels, scales and roles.

Scoping d– What is an IEA?

What is the perspective of an IEA from social scientists, or the ICES IEA groups, ACOM or OSPAR? Is an IEA knowledge building or problem solving; is it a scientific exercise or does it need boundary[10] work? Can pressures and benefits of trade-offs be built into an IEA?

4.2 Defining points of entry

The workshop decided to further explore the scoping question c- who are the actors and what are their roles? This was investigated through a mapping exercise. The North Sea was chosen as a case study. The workshop was reminded that in doing such a mapping exercise it is important to truly brainstorm. Write it **all up** on a piece of paper, and try to structure the differentiation of scales and actors.

The brainstorm was structured around the forms (organizations, companies, individuals) and the types (sectors (impacting on the ecosystem and benefiting from the ecosystem), other 'stakeholders' (such as NGO's), and governmental actors). The results looked rather messy (Figure 4).

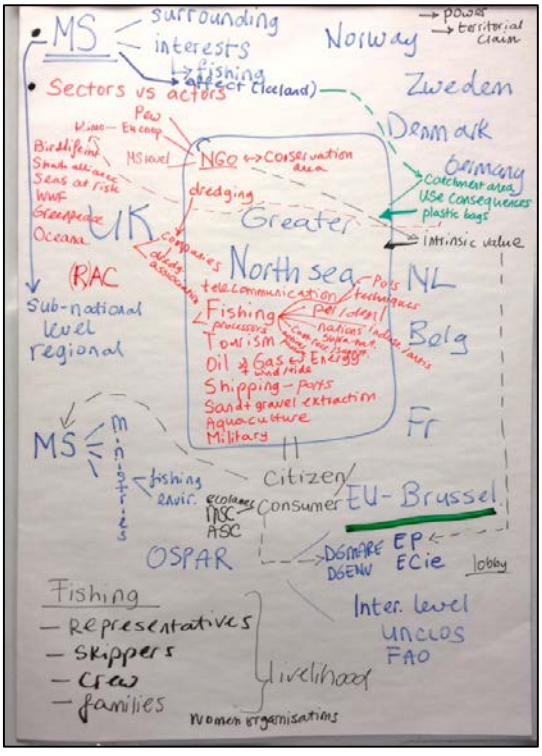


Figure 4. The brainstorm from the exercise we did using the North Sea as an example

[10] Who can, and cannot, participate in scientific practice? Academics have coined this interface between scientists and non-scientists 'boundary work'.

The following step was to reorganize the map into a more coherent scheme (Figure 5). This was done using Visio, trying to show the different 'categories' of actors and levels involved.

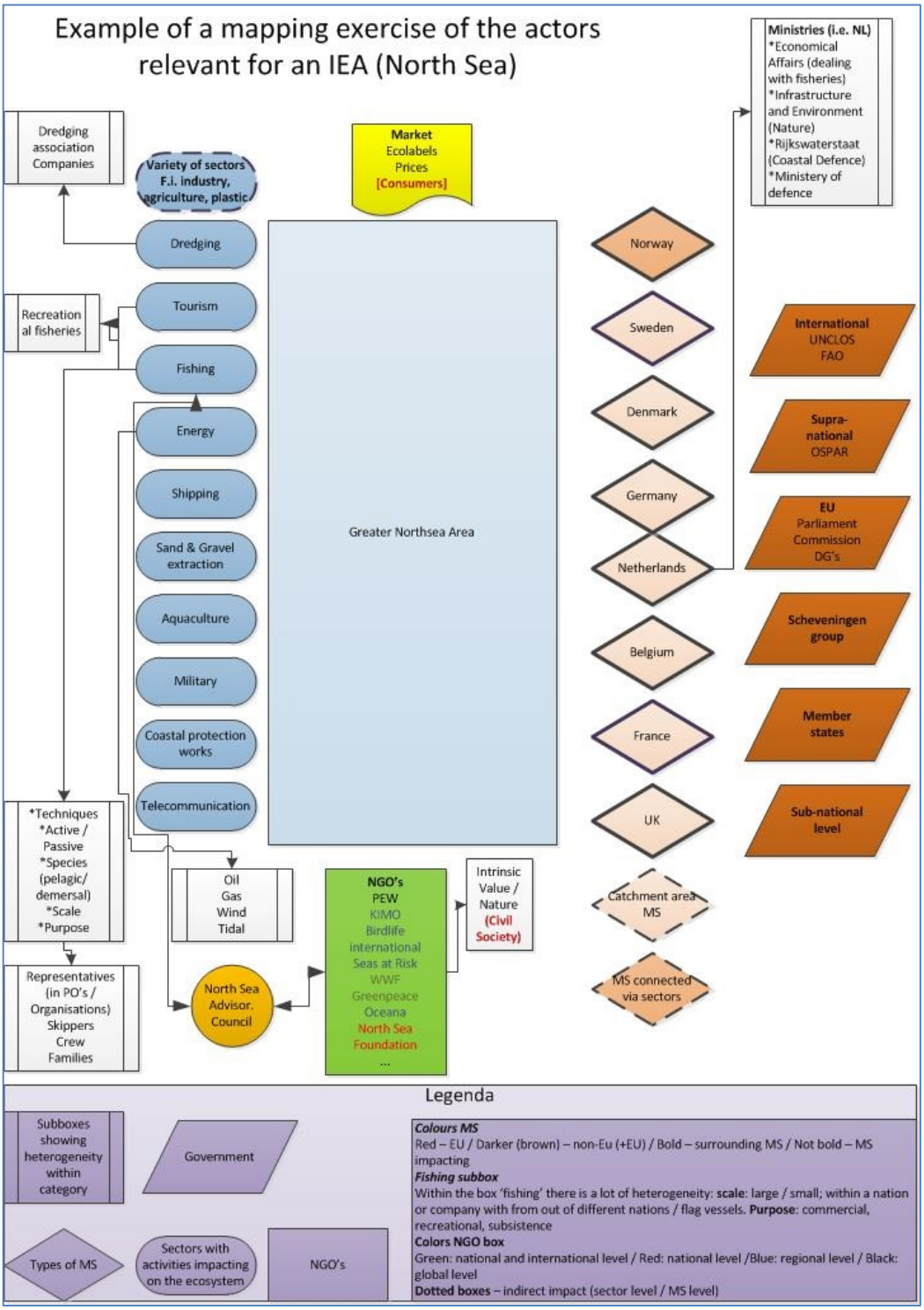


Figure 5. Results from structuring the brainstorm on relevant actors in the Greater North Sea area. Showing sectors (blue), NGO's (green), government actors (brown/red). Market is also placed as a general 'influence' on activities of actors. Subboxes are used to give more detail to the different categories of actors (by Marloes Kraan).

Marloes Kraan further explained the schematic:

"The subboxes are used to show that within certain 'groups' sublevels can be relevant. For instance; different ministries in a member state; different levels of forms of actors: companies or associations. Also a sector such as fisheries can be further worked out in its heterogeneity – types of fisheries (pelagic / demersal), roles of fishers (representative, skipper or crew). Also within NGOs it is useful to see at what level the organizations operate, some at sub-national level, some at national level, some at national and international level and some are a consortium of a group of NGO's working at the regional or EU level.

Market is a bit of a strange category (hence the different formed box). It is just to say that market has its influence on the sectors operating in an ecosystem; it's influence has been reduced (for simplicity reasons) to two 'things': prices (for instance the prices fishers get for their fish, or the oil price – impacting on many sectors, directly for instance on shipping / fishing) and eco-labelling for fisheries / aquaculture (MSC, ASC) – it in fact is a form of governing via the market (consumers). Perhaps other kinds of market influences can be discerned – impacting on the sectors. The level of detail of this, depends also as to how much the 'human system' will be considered in the IEA's.

The role of civil society at large is 'put in' / assumed at a couple of places; consumers at the market box, civil society in a subbox connected to NGO's. Some NGO's have members / are supported by donations so it is assumed those people support the work of the NGO. It is assumed at the parliaments at the Member state level and at the European level (people vote for politicians, politicians decide on policies impacting on the use of the ecosystem).

Conservation could be seen as a 'use' of the ecosystem. It is now not in this overview as such. It is assumed that NGO's aim for it (at different levels, in different ways, with different goals) and that governments decide on what they will protect and how.

The dotted box at sectors is a 'place' to put in other sectors that directly or indirectly impact on the ecosystem – for instance agriculture, industry via rivers discharging in the sea (eutrophication). Or garbage from land ending up in sea (plastics), sewage (medicine substances).

In the member states section, member states surrounding the sea are mentioned (partly EU and non-EU), then there are member states 'connected' via their sectors doing activities in the North Sea (for instance shipping, oil and gas, fishing), and member states in the catchment area –via the rivers- of the North Sea (for instance Switzerland)."

Following the exercise participants from the IEA groups commented on the usefulness of the exercise. Whereas it was seen as a useful way of getting more insight in the landscape surrounding their work, it was also seen as a complicating activity, spurring a lot of debate about types of actors, and how to structure them. Some participants questioned who should do this work; can ecologists do this exercise in the absence of social scientists?

The governance subgroup stressed that this kind of exercise helps the IEA groups understand which human activities are of influence on the ecosystem by making use of it in a direct or indirect way. It helps researchers get an understanding of the actors involved in governance. It gives a 'feel' of the importance of seeing different levels.

This exercise also relates to scoping question a: what is the problem you want to solve with your IEA? The governance subgroup emphasized that it is important to understand that while mapping the actors that benefit from and impact on the ecosystem is an important step, it doesn't cover everything. The activities of the sectors are not only impacted on by rules and regulations of government bodies but also by the sec-

toral policies, by the market and by the behaviour of people working in these sectors. In addition these people will all have their own perspective as to what the problem is and what possible solutions there are.

The level of detail you would want to put into a mapping exercise depends on what the outcome is of the discussion suggested under scoping question d: What is an IEA? Is the human system part of an IEA? If yes, do we also need to gather data on it, describe what happens there? That will require knowledge from the social sciences (recommendation b: assess which knowledge you need). It was commented that this exercise of selecting actors to talk to about the IEA, might do more harm than good. The governance subgroup suggested that also by not doing this, there is the risk of doing harm.

5 Uncertainty, credibility and legitimacy of qualitative decisions

Throughout the workshop the issues of uncertainty, credibility and legitimacy of the developing IEA processes were raised. It was assumed by most participants that IEAs would involve combining knowledge and information of differing integrities and certainties; with some being more quantitative and other more qualitative (Dankel *et al.*, 2012). As mentioned above, methods are already being developed to address some of these challenges. However associated with the challenge of working with information with differing certainties, we need to ensure that our approaches are accepted as credible (Levin *et al*., 2014). An illustration of this was the proposal, in the absence of data, to include more expert judgement in the previous OSPAR Quality Status Report (QSR). This approach was dropped at the time due to criticism by some researchers. Our experience with providing fisheries advice has also shown ICES that legitimacy is crucial to the acceptance of that advice (van Hoof and van Tatenhove, 2009; FAO 1995).

5.1 Exercise on listing regional priority pressures

The workshop was encouraged to explore these issues by working in subgroups on the subject "how do you produce region lists of prioritized pressures on the ecosystem?". Such lists of anthropogenic pressures are already a key part of the ecosystem overviews and are being used by IEA groups to prioritize their work, and by OSPAR and HELCOM. Three subgroups discussed this issue.

Subgroup 1

Suggested that there were analytical solutions to this challenge. Building databases with enough information would allow you "rationally" prioritize pressures in a region. They acknowledged that building models already incorporated judgement and biases, through their inherent assumptions, but they felt that well trained scientists could evaluate these and create a robust prioritized list. The group mentioned that considering the scale of impacts challenged this approach, therefore the objectives for the prioritization needed to be determined before the process began. When prioritizing the cost of mitigation measures should probably be built into the objectives. Any approach should consider a risk assessment that combines severity with probability of occurrence. However, the subgroup did question who should set the limits for these evaluations.

Subgroup 2

Suggested that it was important to consider that this was an applied process. It engaged with policy developers, makers, implementers and researchers. The prioritization process should be framed within an understanding of the governance, ecosystem and social state in the ecoregion being considered. This understanding could then drive the prioritization process. Under the ecosystem approach, the prioritizing must consider scale and spatial processes. The suggested mechanism was a build-up of spatial layers of pressures, with assumed interactions, which could inform prioritization considering space and time. This was not seen as a "pure science" exercise, especially when managers needed to be pragmatic about the trade-offs between economic benefit and potential pressures. Was it important to prioritize pressures for which there were no mitigating measures?

Subgroup 3

Suggested that the purpose of the prioritization was central to determining the mechanism. It could be about setting research priorities, informing society about the need for action, or building a list for management action and implementation of measures. Any approach should highlight how decisions were made, who was involved, and document why they were engaged in the process. The methods used should identify the pressures in relation to the ecosystem component you wish to advise on. The subgroup also raised the issue of time, space and scales. Should the list include all pressures active, even those where mitigation measures were recently put in place, and further action was likely to be unnecessary? The prioritization process should be acceptable to those using the outcome. The subgroup raised the issue that ranking priorities may suggest a degree of certainty that does not exist. It might be better to state the top five or three. Some of the group felt that the number of pressures of concern might vary by ecoregion (e.g. Baltic Sea compared to Norwegian Sea). The subgroup also mentioned that there is a tendency for scientists to spend much time defining the words used for the pressures (e.g. OSPAR or ODEMM approaches), which results in lists that others in the project understand, but means very little to wider society (e.g. abrasion and smothering).

Summary

Although the three subgroups thought that the task of creating lists (prioritized or not) of pressures per region was challenging, they did not see it as an insurmountable problem. They recognized that the process should be open and transparent and be carried out within an understanding of the purpose and context of the list. They all thought that approaches and methods to produce such lists were already available. The groups differed in the degree to which they saw the process as a dialogue or engagement with society. But all noted that the degree of uncertainty was high and such a list of impacting pressures would have implications for society and decision-makers if it was produced by ICES and published as part of the formal advice.

It is worthwhile to recognize that the subgroups differed considerably in their understanding of who (science actors and / or non-science actors) should / could be involved in prioritizing. Subgroup 1 saw a key role for scientists in this activity, whereas the other subgroups either *also* (3 - depending on the purpose of prioritization) or *preferably* (2) saw a role for non-science actors. This is quite a fundamental debate and is linked to the question what is an IEA (see scoping question d in 4.1); a scientific assessment of the natural system or an assessment of (positive and negative) effects of the human system on the ecosystem in which methods of joint fact-finding can be used. It is also linked to the question how you, as a scientist, envisage your role and how you value trade-offs in credibilityvs.saliency and legitimacy (Cash *et al.*, 2002).

5.2 Credibility through knowledge and data quality assurance

WKRISCO had asked the IEA groups to highlight how they were thinking about ensuring quality control, transparency and open data access. The workshop was addressed by Neil Holdsworth, the head of the data and information department in the ICES Secretariat. He highlighted that when providing advice or data services or products, there were now internationally accepted standards that were being expected by our partner organizations. This implies that the IEA groups should start to consider issues of data control and management more carefully and that ICES as a

whole needs to move to a new situation (see figure 6 for Neil's illustrations of the concepts). Groups need to consider access rights, business process for analysis and downloading data, decision-making needs to be traceable and reproducible. In the fisheries advice a system is being built around formal data calls, and with traceable procedures for data storage and access. Turning up with "your data" on a laptop should not be seen as a robust and credible approach. This also relates to safeguarding good scientific practice as laid out e.g. by the German DFG:

"Being able to refer to the original records is a necessary precaution for any group if only for reasons of working efficiency. It becomes even more important when published results are challenged by others. Primary data includes measurement results, collections, surveys, cell cultures, specimens of material, archaeological finds and questionnaires."

Systems and procedures are already being built for work between ICES and OSPAR, HELCOM, and the MSFD. The ICES data centre is playing a role in the EU initiatives WISE Marine, INSPIRE and EMODnet. The ICES data centre is already providing datasets for analysis by IEA groups (e.g. WGINOSE recent data request). The process to provide these datasets was a two way dialogue between the ICES data centre and WGINOSE. The important point is that it should also be seen as simplifying the work of the IEA groups as they have easier access to data and it helps them to fulfil requirements from journals requesting that data used in a manuscript should be available.

To produce credible advice on ecological and environmental matters, a process must be traceable and transparent (data, knowledge, method and decisions). This means that any expert judgement should be documented when used in advice. Thus we need to have clear documented processes, when we provide future advice to EU, OSPAR, HELCOM, Norway, Iceland, or Russia.

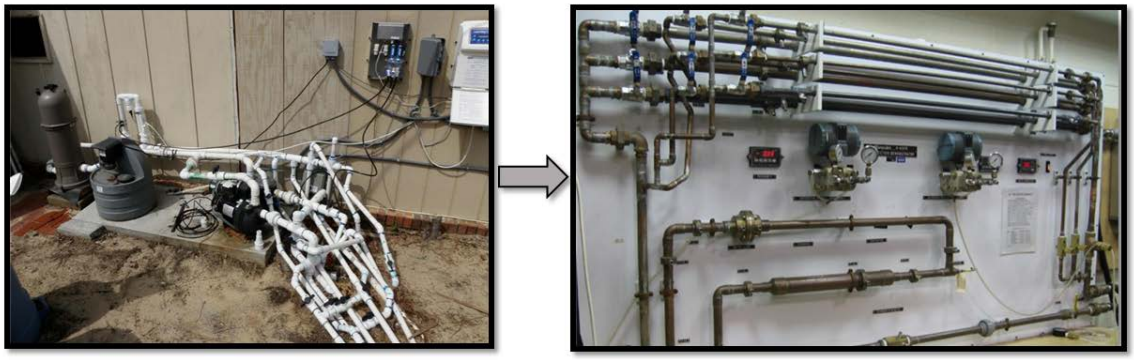


Figure 6. Data and information systems that support IEA processes need to be traceable and transparent.

5.3 From research and development to operational IEAs

The document that proposes the route to implementing the ICES strategic plan, suggests that ICES will soon provide example, or demonstration, IEAs. It is proposed that these might act as boundary objects[11] to open discussions with partners and recipients of advice. There is however still tension between those in ICES that see de-

[11] Items of information perceived and used differently by different observers in light of their own biases, experiences, or needs.

veloping IEAs as a scientific exploration of (predominantly natural science) methods, and those that want to obtain an operational product relevant to policy and credible to the wider society and stakeholder groups. There was much discussion within WKRISCO, but this core tension was not resolved. It was signalled that this probably requires further discussion and scoping within ICES (ACOM and SCICOM) as well as within the IEA groups. It was agreed however, that it was unlikely that the current groups have the intention nor the within-group expertise or resources to engage with stakeholders. Meaningful processes of stakeholder participation would probably have to be facilitated by specialists (see for instance Kraan *et al.*, 2014 for the approach taken in ODEMM). It was also questioned if the IEA groups have the mandate of performing a scoping exercise to derive common objectives. Any salient process of scoping through dialogue would probably have to be accepted by the responsible management bodies. It also needs to be taken into account that the prime example of IEA development and the process of operationalization described by P. Levin at the 2014 ASC was a heavily resourced process.

6 Knowledge Requirements for the Ecosystem Approach for the forthcoming five years

6.1 OSPAR

General discussion

Most of the work of OSPAR also in relation to the next Quality Status Report (QSR) is driven by the need of the contracting parties apply the ecosystem approach to management of marine activities and in doing so implement the Marine Strategy Framework Directive. However there are still other legal texts in the European context with directives like the Water Framework directive, Birds and Habitat Directive which set the scene for the knowledge needs. These frameworks are partly relevant or not relevant to non-EU contracting parties of OSPAR, and members of ICES. The discussion in the subgroup thus also touched on areas, which are of more general interest.

OSPAR science needs list

OSPAR has published a document on its science needs accompanying its 2014 science agenda document (OSPAR, 2014). The main areas of policy interest are biodiversity and ecosystems, eutrophication, hazardous substances, oil and gas industry, radioactive substances and crosscutting issues. Although they have listed the gaps in more detail, the main knowledge gaps are identified being integrative assessment methods, knowledge of cumulative effects and the development of indicators. OSPAR puts the ecosystem approach as being core to its activities, however it also is still not explicit where the social and economic sciences should be linked in the system.

Social and Economic sciences

The integration of social and economic sciences and probably also arts and humanities (e.g. history) in the integrated ecosystem assessments is a highly discussed topic. It seems to be clearly understood that there is the need for developing social and economic indicators to evaluate effects of management measures on human activities to make trade-offs of decisions more explicit. This is illustrated in the example activity/pressure/state diagram for the ecosystem overviews and the "activities" side of it (Figure 3). It needs to be clarified, how social and economic pressures and impact/welfare indicators are linked into the system. On the other hand the inclusion of society to derive the objectives and to add legitimacy and credibility to the processes developed also needs the help of social sciences to set up a proper process of stakeholder engagement. Thus the role of these disciplines in the whole process needs to be clarified.

Define the scales you need to work on and what are the linkages?

Most ICES IEA groups already divide the analysis in subregions. However it became clear that some work within OSPAR is clearly related to coastal areas and that some pressures might not rank high in a regional approach, but become relevant on a local, coastal scale. Coastal areas are currently not focused on by IEA groups. This became apparent in the conclusion that fisheries is still the main driver in the open Norwegian Sea, whereas it completely changes in the coastal areas and the fjords, where aquaculture is a main driver, with introduction of species, eutrophication, etc. The scale of the analysis might also need to be linked to the scale of the management units. Different sectors have different scales on which they are managed and thus the

assessment and more important the advice needs to be on that scale. The scaling issue is also relevant to monitoring frameworks. Currently the monitoring done by OSPAR and ICES are fitting a specific purpose, but it might be difficult to link, because the purpose might change (e.g. sampling of benthic flora and fauna for the use in biodiversity indicators or for deriving prey fields for commercially important fish species).

How do pressures affect the ecosystem – cumulative effects and linkages?

One major gap identified are the links between different drivers and the cumulative effects of pressures on ecosystem components. Whereas some pressures are linked to drivers, which can be managed directly to change the pressure (like fishing), it is less so for others such as seabed release of contaminants due to fishing activity.

Cross-sectoral knowledge and forward looking aspects

In relation to cumulative effects, a clear gap is the lack of expertise on other sectors than fishing. This cross-sector expertise would not only be needed to evaluate the current set of activities taking place in the marine realm, but would also allow for a more forward looking approach, taking into account upcoming issues like deep-sea mining and fishing on meso-pelagic fish.

6.2 HELCOM

HELCOM is in 2014 starting the HOLAS II project that will develop a second HELCOM holistic assessment of the ecosystem health of the Baltic Sea. The product should follow up the goals and objectives of the Baltic Sea Action Plan and also be developed so that it can be used a joint "roof report" for HELCOM Contracting Parties that are EU Member States in the 2018 MSFD reporting of Articles 8, 9 and 10. Key components of the project are to further develop tools for assessing status of and pressures on the environment. The project will follow the DPSIR approach and also address social and economic impacts and to some extent also follow-up existing and planned measures and their appropriateness to achieve Good Environmental Status.

In the development of indicators, monitoring programmes, programmes of measures and the development of the upcoming holistic assessment, a number of knowledge needs have been already identified or are foreseen. Some of these knowledge needs were discussed in relation to the work of WGIAB.

How to define GES for indicators?

HELCOM is now well underway with the development of indicators with associated quantitative boundaries or intervals that represent good environmental status (GES) for the individual indicators. So far no analysis has been carried out to evaluate if GES for different indicators are compatible i.e. if they can be reached at the same time. It was discussed whether there is a need to consider if GES across criteria is consistent. A way forward would be for WGIAB to address this question using a case study, and evaluate how to reach GES for certain indicators using models.

Ecosystem understanding will be required to define ecologically relevant GES boundaries, which will be "achievable" by managing human activity (pressure reduction). It was further proposed that in evaluating GES boundaries for ecosystem status indicators, a step forward would be to conduct a root-cause-analysis to identify pressures and drivers. Furthermore, analysis of anthropogenic drivers on the state of the marine environment can widen the scope of intervention options by identifying societal phenomena and actors influencing pressures. WIGAB was optimistic that info

about both drivers and impacts could be synthesized into indicators and incorporated into an IEA, provided data and expertise is available.

What are the regional monitoring requirements for delivering an assessment on ecosystem status?

Already developed indicators under HELCOM will require monitoring of selected variables. For these parameters consideration will be needed on the spatial and temporal resolution of monitoring programs related to the scale of assessment (HELCOM assessment units).

WGIAB highlighted that monitoring needs for some parameters have previously been evaluated, with zooplankton and stomach content analysis identified as key gaps. The group also had a general discussion about monitoring strategies where the relative roles of "basic" monitoring and "adaptive" monitoring strategies (space, time and variables) were discussed. It was highlighted that international coordination was key, and that different interest groups may have different goals when designing monitoring programmes (i.e. resource limitations).

How to differentiate between changes as a consequence of successful management actions and natural variability of the ecosystem?

Assessment tools as used in the follow-up of marine policies are intended to support an evaluation of effects of measures. But how to distinguish changes in status and anthropogenic pressures from changes in climatic factor? Especially in the Baltic Sea natural variation (temperature, salinity) may be large, which includes longer-term trends. Thus differentiating between long-term ecosystem changes and consequences of management measures taken is critical.

It was discussed that several modelling approaches were available many of which are in use by researchers affiliated to WGIAB. Similarly WGIAB could draw from several research projects working on this issue. It was highlighted that different anthropogenic pressure types exists that vary in intensity, frequency, spatial scale that need to be balanced with natural disturbances/ variation. Joint analysis of empirical monitoring data and outputs of process-based models could serve as a framework for harmonizing existing approaches to distinguish between natural variability and effects of human interventions.

How to define environmental targets for pressures?

HELCOM has defined environmental targets for nutrients (input reductions) and will now explore how to define environmental targets also for other pressures. Ecosystem understanding of state and pressure relationships will be required, as well as the cumulative effects and synergy between pressures that may be basin-specific. Non-quantitative/short-term (intermediate) targets were discussed as an option for cases where there is high uncertainty, however to trigger management measures a number or percentage was viewed as very important. In defining targets acceptable variation was viewed as important aspect, but a precautionary principle was highlighted. Pressure reductions to achieve states may also be resolved spatially and not necessarily by specific percent reductions in overall pressure (e.g. trawling impact on seabed).

WGIAB highlighted that data on nutrient reduction in terms of input at basin and sub-basin level (not only concentrations) would support further analysis of the group and that HELCOM PLC data would be an avenue. WGIAB has not used nutrient

loading data at sub-basin scale in the IEAs so far, but it may be possible to include them on a basin-scale assessment.

What are the economic and social impacts of management actions taken to improve ecosystem state?

Trade-offs in management measures suggested to improve ecosystem state will have both economic and social impacts. These possible trade-offs are essential to making informed management decisions.

Spatial data needs for assessing impact of pressures

For the assessment of impacts of pressures there is a need to improve pressure data layers and ecosystem data layers, both in terms of resolution and to cover additional features. In terms of fish and fisheries related data; HELCOM has in particular identified the need for species distribution maps (probability maps), habitat distribution maps (nursing/spawning/feeding grounds), and VMS data for use in the Baltic Sea Pressure indices and for the pre-core indicator 'Cumulative impacts on benthic biotopes'.

7 Timelines

WKRISCO compiled relevant events in the forthcoming ten years from information provided by the relevant partners at the meeting (Figure 7).

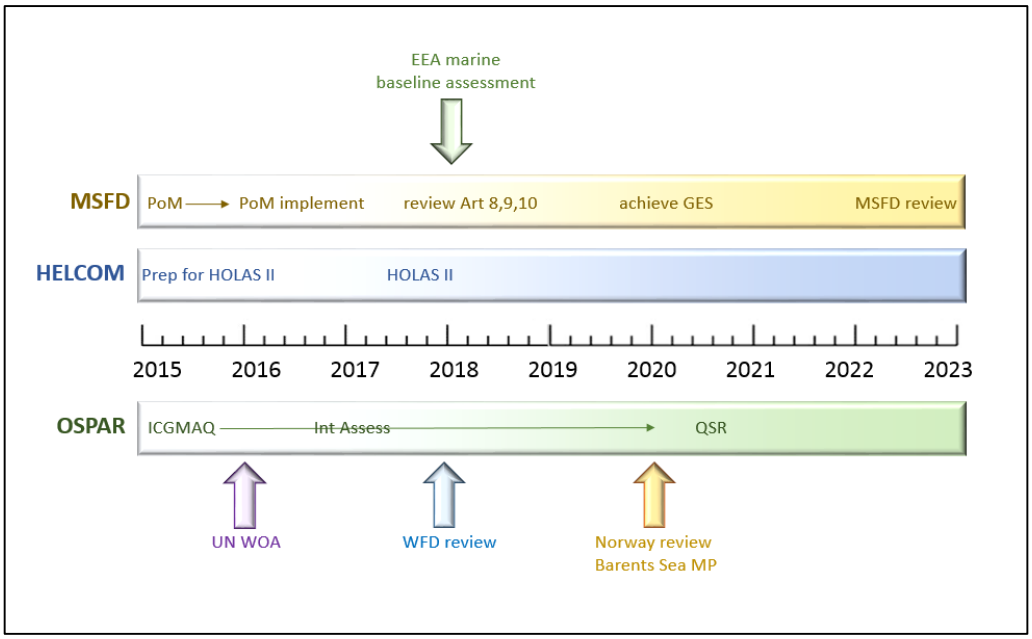


Figure 7. Relevant time lines from partners for IEA groups in ICES. MSFD- marine strategy framework directive, EEA- European Environment Agency, PoM- Programme of measures, Art- Article of the MSFD, HOLAS – Holistic Assessment of the Baltic Sea, ICGMAQ - Intersessional Correspondence Group to Manage Preparation and Publication of the Intermediate Assessment 2017 and the QSR21, Intermediate Assessment, QSR- Quality status report, UN WOA- United Nations General Assembly World Ocean Assessment, WFD – Water Framework Directive, MP- Management Plan.

8 Recommendations and Conclusions

There are differences in the priorities, objectives, and available expertise between the groups. The WK stimulated chairs to reflect on the concept of integration within their groups and the context of their research. The working group chairs appreciated the opportunity to share ideas.

The Chairs of WKRISCO reflected that there appears to be a difference in opportunities offered to those groups focused within the EU and those which are embedded in national or bilateral management contexts (e.g. USA, Canada, Norway and Russia). ICES appears to provide a clearer route towards implementing operation advice for IEAs within the CFP and MSFD (including working with partners such as OSPAR and HELCOM) than within the other frameworks.

The challenge is to how to operationalize methods and work towards demonstration advice on IEAs. If the demonstration IEAs remain hypothetical, rather than being linked to actual real life challenges, they run the risk of being irrelevant and not bringing about productive engagement with society, scientists and managers. The process of IEAs is resource-demanding and thus it is likely that attempts to build on selected examples will not be sufficiently resourced. IEAs should have a clear connection with marine governance structures in the (eco)region that is assessed.

Interaction between natural and social scientists on social drivers and impacts is still considered relative novel. The inclusion of social scientists (e.g. from economics, political science, sociology or history) needs to be considered regionally, and researchers must be aware of the challenges brought about by the differences in scales and resolutions of processes within each field of research.

The experts engaged in WKRISCO will develop an ICES workshop to investigate guidance on stakeholder engagement in an IEA process. WKRISCO also saw the newly developing proposal for an ICES strategic initiative on social and economic science as important, especially when needing to consider ecosystem services, benefits and impacts across the ecoregions.

It is clear that both OSPAR and HELCOM are keen to engage with the ICES process and provided input to the workshop. Some of their broad objectives and specific needs and medium term requirements are given in chapter 6 of this report. These should be considered by ICES IEA groups as they look forward to future R&D needs and future terms of reference for their groups.

The WKRISCO discussions resulted in the following guidance for the IEA process within ICES:

- Clearly define the role and responsibility of the different groups involved, looking at expectations and equating these with resources and priorities.
- Aim to identify the “big signals” in the ecosystem that are relevant to management of human activities, balancing both the services derived by humans and the impacts of their activities and indicate the scale of the effects to inform decision-makers. This could be done by accompanying advice in the current (fisheries) advice framework with information about the scale of effects of other human activities to visualize the need to take these explicitly into account and thus allow decision-makers to establish necessary communication on the management level.

- Aim to develop an indicator-based framework to inform assessment and advice of relevant changes in the environment.
- Aim to use both time-series of information and the incorporation of best available knowledge in the IEAs. Time-series can come from empirical sources, modelled sources and integrated sources (combinations of empirical and modelled). When using expert judgement or qualitatively informed knowledge the process should be transparent and the reasons and evidence of decisions should be recorded.
- Aim to include evaluation of uncertainty in both empirical and modelling data products. Consider how these uncertainties combine within the IEA. Uncertainty should encompass structural and parametric uncertainty, but also other uncertainty caused by the lack of agreed methodologies, changes in methodologies etc.
- Be prepared to defend the choices made during the IEA. This includes why a respective ecosystem model has been used as a platform for management strategy evaluation. When it becomes operational, an IEA should be scientifically credible and socially legitimate.
- Accept prioritization of the challenges and be prepared to develop these using specific and relevant case studies.

When exploring IEAs in future researchers should ask themselves:

- What is the problem you want to solve?
- What resources are available?
- Who are the actors and what are their roles?
- What is an IEA (in the context of the problem to be solved)?

9 Acknowledgements

The chairs of the workshop would like to acknowledge the participation of members of the EEA and the secretariats of HELCOM and OSPAR.

website links:

HELCOM: http://helcom.fi/

OSPAR: http://www.ospar.org/

EEA: http://www.eea.europa.eu/

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Annex 1 Terms of Reference

WKRISCO reports to the Benchmark Steering Group (BSG) – approved by SCICOM and ACOM intersessionally, May 2014

Resolution

2013/2/ACOMSCICOM02 The **ACOM/SCICOM Workshop on Regional Seas Commissions and Integrated Ecosystem Assessment Scoping** (WKRISCO), chaired by Mark Dickey-Collas*, ICES, and Jörn Schmidt*, Germany, will meet at ICES Headquarters, Copenhagen, Denmark, 17–20 November 2014.

The workshop will have two main objectives; first to summarize progress made and methods used across the ICES integrated ecosystem assessment (IEA) groups and second to scope with OSPAR and HELCOM the science needs for upcoming regional assessments (QSR and HOLAS). The aim of these is to provide the IEA groups with a panorama of their work across the scope of regional seas commissions (RSC) activities. The workshop will also provide a forum to build a timeline for IEA work, in response to the scoping exercise.

The four day workshop will take place in two phases; the first 2 days will synthesize the work of the IEA groups and the following 2 days will focus on the scoping exercise between ICES and the RSCs.

WKRISCO will report by 15 December 2014 (via BSG) for the attention of SCICOM, ACOM and SGIEA.

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected deliverables
A	Review, summarize and compare the methods of regional ICES IEA groups, including quality assurance mechanisms.	Serves as a knowledge base and as comparison to other regional approaches	Integrated ecosystem assessments	WK first two days	White paper that documents methods used and how a quality assurance process could be set up for IEAs in ICES
B	Provide a forward looking systems analysis across the ICES ecoregions of the governance and legal context that impact on IEAs.	What is the panorama in which IEAs operate?	Integrated ecosystem assessments and the human dimension	WK first two days	Brief summary report with recommendations on needs of advice
C	Explore with HELCOM and OSPAR their science needs (R&D requirements for upcoming HOLAS and QSR analyses) to inform ICES IEA groups...	The ICES IEA groups have expressed frustration at a lack of scoping about RSC objectives and science needs.	Integrated ecosystem assessments and the human dimension	WK second two days	Another white paper to inform the IEA groups about the

Summary of the Work Plan

Year 1	White paper 1 and 2 and Brief Summary report

Supporting Information

Priority	High, this WK is seen as a key strategic move forward that will help the IEA groups to position their work in a broader context and increase their visibility in the system. It also allows the IEA groups to consider the priorities of the RSCs as the RSCs prepare for their next rounds of ecosystem assessments and to build up synergies with RSCs and possibly other groups working on similar issues (e.g. within EU or other projects)
Scientific justification	This workshop follows on from WKBEMIA 2012. It supports the IEA groups for the next round of development and provides two products, a cross comparison of methods used and being developed by the IEA groups and a scoping exercise of the science needs of OSPAR and HELCOM in preparation for the next QSR and HOLAS rounds.
Relation to Strategic Plan	Developing and applying greater ecosystem understanding is core to the new ICES strategic plan. The IEA groups are the key mechanisms (along with a new benchmark process) by which ICES plans to apply integrated ecosystem understanding to management needs.
Resource requirements	Two meeting rooms at ICES HQ, webex facilities
Participants	IEA group chairs or members, participants from OSPAR and HELCOM working on HOLAS and QSRs, BSG chairs, SSGRSP (then SGIEA) chair, ICES Secretariat
Secretariat facilities	SharePoint site, secretariat support for reporting.
Financial	None
Linkages to advisory committees	ACOM
Linkages to other committees or groups	SSGRSP, all IEA groups, methodological groups like WGIPEM, SGIMM, WGSA
Linkages to other organizations	HELCOM and OSPAR

Annex 2 Agenda WKRISCO

Synthesis of ICES IEA work

17 November 2014

10:00 Welcome and Introductions (including resolutions)

10:10 IEAs and ICES strategic plan

10:30 Ten minute IEA group presentations addressing key questions:
a) current tool and method development
b) list choices/prioritization of ecosystem components/specific activities or pressures
c) highlight any case studies (areas, species, sectors)
d) what are key gaps and needs?
e) describe open/traceable data approaches, quality assurance of products
WGIAB, WGINOSE, WGINOR, WGIBAR, WGNARS, WGEAWESS

13:00 Lunch

14:00 Open discussion on governance issues across the IEA regions.

15:45 Coffee

16:00 What tangible steps can we take to improve the IEA initiative within ICES?

18:00 Close

18 November 2014

09:00 Work in subgroups to prepare bullet paragraphs on:
1. Methods being developed and key gaps and needs
2. Prioritization and case studies
3. Data/quality assurance issues
4. Challenges caused by governance and management context

14:00 Plenary report back from each subgroup

15:30 Coffee

16:00 Future challenges and potential milestones for the ICES groups for the next few years.

18:00 Close

19 November 2014

Scoping with OSPAR and HELCOM

09:00 Welcome and Introductions

09:30 Summary ICES IEA groups, Ecosystem Overviews, summary of last 2 days work

10:30 OSPAR future vision – Knowledge needs for QSR- integration of the evidence of decisions

11:00 Coffee

11:15 HELCOM future vision – Current expectations of knowledge needs for HOLAS II

11:45 Discussion including how IEAs, HOLAS, QSR relate to MSFD

13:00 Lunch

14:30 Professionalising knowledge and data products- working with traceable, open and quality assured information.

15:00 Area subgroups: Priority Pressures: The top pressures in each region.

16:00 2 Subgroups: both on methods and data

What are the highest priority requirements for the next 5 years? Are ICES and the IEA groups feeding into the appropriate channels? (Moved to 20 Nov)

18:00 Close

20 November 2014

09:00 Plenary reporting back

10:10 Project input into the ICES system – DEVOTES (moved to 19 November)

10:30 Timelines – when should knowledge and data tools be available?

11:00 Coffee

11:15 Subgroups: Is it all about indicators and monitoring?
Can we offer tools for assessing trade-offs (including scenarios)?
Can we offer tools to assess cumulative effects?
Pressure verses impact assessments?

12:50 Final comments HELCOM

13:00 Lunch

14:00 Report back

14:30 Report writing subgroups

16:30 Wrap Up including final comments from OSPAR

Annex 3 Participants List

Name	Address	E-mail
Anders Grimvall	Swedish Institute for the Marine Environment PO Box 260 S-405 30 Gothenburg Sweden	anders.grimvall@liu.se
Andrew Kenny (correspondence)	Cefas Pakefield Road NR33 0HT Lowestoft Suffolk UK	andrew.kenny@cefas.co.uk
Ángel Borja	DEVOTES Project coordinator AZTI Herrera Kaia Portualde z/g 20110 Pasaia (Gipuzkoa) Spain	aborja@azti.es
Anne Christine Brusendorff	ICES H. C. Andersens Boulevard 44-46 1553 Copenhagen V Denmark	anne.christine@ices.dk
Darius Campbell	OSPAR Victoria House 37-63 Southampton Row WC1B 4DA London UK	Darius.Campbell@ospar.org
David Goldsborough	VHL, University of Applied Sciences PO Box 1528 8901 BV Leeuwarden Netherlands	david.goldsborough@wur.nl
David Reid	Marine Institute Rinville Oranmore Co. Galway Ireland	david.reid@marine.ie
Edda Johannesen	IMR Nordnes PO Box 1870 5817 Bergen Norway	edda.johannesen@imr.no
Elliott Brown	DTU Aqua Jægersborg Allé 1 2920 Charlottenlund Denmark	elliot.j.brown@hotmail.com

Name	Address	E-mail
Eskild Kirkegaard	DTU Aqua Jægersborg Allé 1 2920 Charlottenlund Denmark	eskild.kirkegaard@ices.dk
Eva-Lotta Sundblad	Swedish Institute for the Marine Environment PO Box 260 S-405 30 Gothenburg Sweden	eva-lotta.sundblad@havsmiljoinstitutet.se
Geir Huse	IMR Nordnes PO Box 1870 5817 Bergen Norway	geir.huse@imr.no
Inigo Martinez	ICES H. C. Andersens Boulevard 44-46 1553 Copenhagen V Denmark	inigo@ices.dk
Johnny Reker	EEA Kongens Nytorv 6 1050 Copenhagen K Denmark	Johnny.Reker@eea.europa.eu
Jörn Schmidt (chair)	Christian-Albrechts-University of Kiel Department of Economics Wilhelm-Seelig-Platz 1 24118 Kiel Germany	jschmidt@economics.uni-kiel.de
Laura Uusitalo	DEVOTES Project SYKE Mechelininkatu 34a PO Box 140 00251 Helsinki Finland	laura.uusitalo@ymparisto.fi
Lena Bergström	Swedish University of Agricultural Sciences Institute of Coastal Research Skolgatan 6 PO Box 109 742 22 Öregrund Sweden	lena.bergstrom@slu.se
Manuel Hidalgo (correspondence)	Spanish Institute of Oceanography (IEO) Moll de Ponent, s/n 07015 Palma Spain	jm.hidalgo@ba.ieo.es
Mark Dickey-Collas (chair)	ICES H. C. Andersens Boulevard 44-46 1553 Copenhagen V Denmark	mark.dickey-collas@ices.dk

Name	Address	E-mail
Marloes Kraan	IMARES PO Box 68 1970 AB IJmuiden Netherlands	marloes.kraan@wur.nl
Sarah Gaichas	NOAA Fisheries Northeast Fisheries Science Center, Woods Hole Laboratory 166 Water Street MA 02543 Wods Hole USA	Sarah.Gaichas@noaa.gov
Scott Large	ICES H. C. Andersens Boulevard 44-46 1553 Copenhagen V Denmark	scott.large@ices.dk
Sebastian Valanko	ICES H. C. Andersens Boulevard 44-46 1553 Copenhagen V Denmark	sebastian.valanko@ices.dk
Steven Beggs (correspondence)	AFBI Headquarters 18a Newforge Lane BT9 5PX Belfast UK	steven.beggs@afbini.gov.uk
Trine Christiansen	EEA Kongens Nytorv 6 1050 Copenhagen K Denmark	trine.christiansen@eea.europa.eu
Ulla Li Zweifel	HELCOM Katajanokanlaituri 6 B 00160 Helsinki Finland	ullali.zweifel@helcom.fi
Vanessa Stelzenmuller (correspondence)	Thünen Institute Institute for Sea Fisheries Palmaille 9 22767 Hamburg Germany	vanessa.stelzenmueller@ti.bund.de

Annex 4 Presentations to WKRISCO from ICES Integrated ecosystem assessment working groups

Each ICES IEA WG was asked to prepare input into the workshop. These are shown below. The groups were asked to address five points:

a) current tool and method development ongoing on in your IEA group.
b) list any choices/prioritization of ecosystem components/specific activities or pressures that have been made by your group
c) highlight any case studies (areas, species, sectors) that have been chosen by your group
d) tell us what you see as the key gaps and needs
e) describe how the group is planning to ensure open and traceable data approaches, quality assurance of products.

WGIAB overview

Laura Uusitalo
Finnish Environment Institute

WKRISCO 17-20 November 2014
Copenhagen, Denmark

Current tool and method development

- DEMO: DEMOnstration exercise for Integrated Ecosystem Assessment and Advice of Baltic Sea fish stocks (e.g. http://www.su.se/ostersjocentrum/english/research/research-at-the-baltic-sea-centre/demo)
- Methods papers (planned to be published in a Special Issue):
  - how to deal with technical issues in statistical analyses of time series, such as the replacement of missing data points in time series and statistical probabilities of detecting regime shifts in time series
- Economic indicators for the German small-scaled coastal fisheries
- *Application of Bayes Nets to ecosystem models for scenario-based management strategy evaluation*

choices/prioritisation of ecosystem components/specific activities or pressures

- We have been prioritising pelagic food webs with a focus on the fish – the main pressures investigated being climate and fishing
- Planned to be highlighted at the 2015 meeting (ToR 3): "Further develop the integrated ecosystem assessment cycle, and apply case studies to investigate trade-offs between different management objectives, including effects on ecosystem services and effects at different spatial and temporal scales".
  - *Need to be thought of after the outcomes of this meeting!*

case studies

- DEMO work on fisheries
- Case studies of ITA on many basins
- Comparison studies of
  - Different basins (offshore & coastal)
  - Coast-offshore systems
- *MSFD assessments*

key gaps and needs

- pressure indicators (such as nutrient loading) in conjunction with the ecosystem ITAs?
- ITA about MSFD / HELCOM CORESET indicators?
- In general, I think we need to align ourselves to support the EU policy instruments (MSFD, CFP) and HELCOM development – keep the science tightly on the core but try to address issues that are, and when they are, relevant to policy making.

WGINOSE - tools,data, approaches

WKRISCO 17–20 November 2014

a) Tool and method development

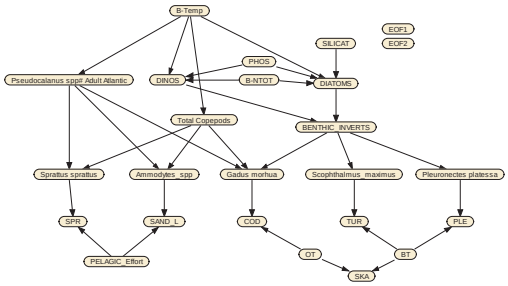
- Bayesian Belief Network (BNs) are being developed by WGINOSE to assess both the relationships between key variables and the combined effects of their potential changes
- BNs consists of (1) a directed acyclic graph (DAG) that denotes dependencies and independencies between the model's nodes and (2) conditional probability tables (CPTs) denoting the strengths of the links between model nodes
- DAG development for the southern (SNS) and northern North Sea (NNS) based on available datasets based on known and assumed node relationships
- The rational of the BN structure was that it should be both meaningful to managers (that is it deals with the ecosystem components of greatest interest or value) whilst at the same time being ecologically 'sensible' and coherent in terms of assessing different management scenarios

b) Prioritisation of ecosystem and pressures

- It was not the groups intention to include all components of a subregional foodweb or a multispecies fisheries assessment, rather having access to annual average time-series data from 1983 for a range of components
- For the SNS and NNS a set of commercially and functionally important fish species have been selected and related to those triggering key variables with respect to physics, nutrients, plankton, landings and fishing effort

c) Case studies – Southern North Sea

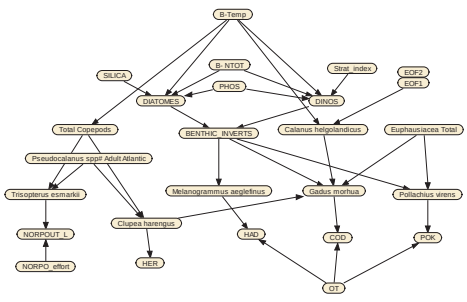
- Based on good quality time-series data (1983–2012) which is spatially representative of the SNS subregion
- Selected fish species of commercial and management interest: sprat (*Sprattus sprattus*), sandeel (*Ammodytes spp.*), cod (*Gadus morhua*), turbot (*Scophthalmus maximus*) and plaice (*Pleuronectes platessa*).



Note the EOF nodes (PCA's of current fluxes) are not yet linked to any other model nodes.

c) Case studies – Northern North Sea

- Based on good quality time-series data (1983–2012) which is spatially representative of the NNS subregion
- Selected fish species of commercial and management interest: Norway pout (*Trisopterus esmarkii*), herring (*Clupea harrengus*), haddock (*Melanogrammus aeglefinus*), cod, and Pollock (*Pollachius virens*)



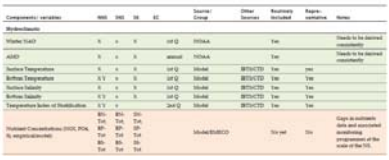
d) Gaps and needs…or next steps

- A sound explorative analysis of the correlation matrix of the respective sets of variables.
- The required time series data for the NNS und SNS case has been completed by September 2014.
- Principal Component Analysis (PCA) will be applied to explore the covariance between variables
- PCs will be used to represent the essential behavior (reaction) of groups of species, for instance, leaving out details considered irrelevant for the whole system or having no clear interrelationship with the forcing parameters represented in the BN
- The use of PCs does not preclude the representation of individual species in the BN. But PCs may act as parent nodes and interactions of individual species with (e.g. abiotic) forcing variables may all be channeled through these PCs

➢ Time consuming analysis and exceeds by far the anticipated meeting time

d) Traceable data approaches and quality assurance

- Metadata tables



- Where applicable publication of R scripts used for data analyses

WGNARS: Northwest Atlantic Regional Sea

Tool and method development

- Worked example of linked IEA components
  - IEA scoping (2013)
  - Identifying indicator thresholds (2013)
  - Indicator performance testing (2013)
  - Risk assessment (2013)
  - Developing SMART objectives (2014-2015)
  - Indicator selection and evaluation (2014-2015)
  - Management strategy evaluation (planned for 2016)
- Advice on process for operational IEA implementation
  - What worked and what didn't?
  - Who else needs to be involved?
  - Iteration between science, policy, management

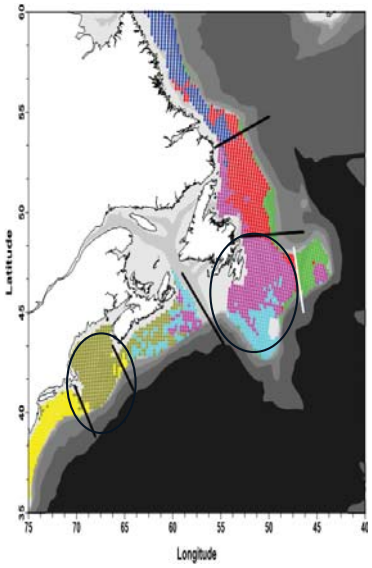
Choice of ecosystem components, activities, pressures

- Apply combined **conservation and human dimensions** management objectives
- Identify key **large-scale drivers** that influence the whole NW Atlantic
  - Bottom temperature, surface temperature ice timing and cover, freshwater input, stratification and salinity
  - Fishing and energy development /exploitation
- and how **ecosystem response** varies across spatial scales (2015)
  - Multiple species B and P, food webs, habitats
  - Social and economic benefits

Case studies

Selected WGNARS ecoregions (2014)

Some previous work at US Northeast shelf scale and smaller, E and W Scotian shelf, combined Labrador/Newfoundland



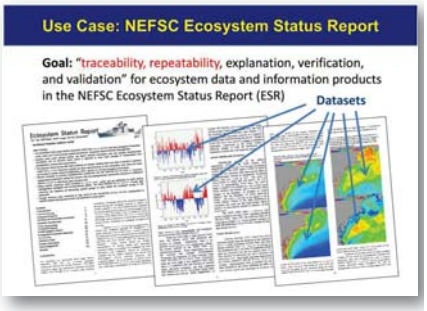
Key gaps and needs

- Will continue to struggle with scale issues
  - Connected set of ecoregions
  - Climate impacts substantial and a moving target
- Will continue to struggle with governance and process
  - WGNARS has no direct interface with US and Canadian management advice (though individual members may)
  - US and Canadian ocean governance a moving target
- Fisheries oriented, no energy industry participants
- Engaging managers and diverse scientists can be difficult

Open/traceable data approaches, quality assurance of products

Products to date mainly peer reviewed papers

Informatics approach in progress for US ecosystem status report, multispecies assessment



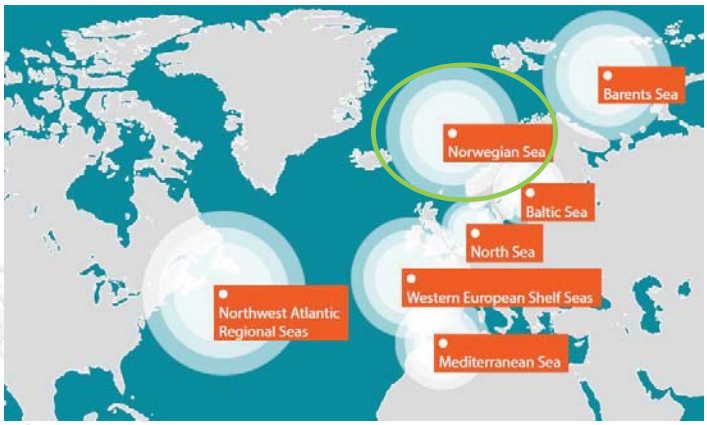
PIs: PeterFox (RPI), StaceBeaulieu (WHOI), and Andy Maffei(WHOI)
Sponsor: National Science Foundation

Working Group on the Integrated Assessments of the Norwegian Sea (WGINOR)

Geir Huse

WKRISCO, Copenhagen 17-20 November

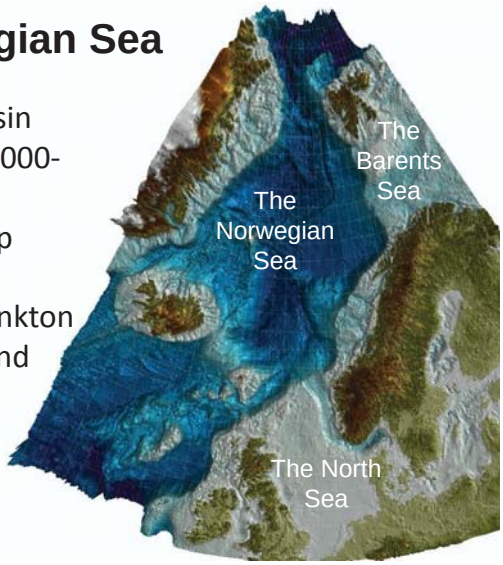
ICES IEA Working Groups



- WGINOR has met twice: in August 2013 and 2014

The Norwegian Sea

- Deep water basin with depths of 2000-4000 m
- Key role in deep water formation
- Exporter of plankton to the Barents and North Seas



WGINOR Terms of reference:

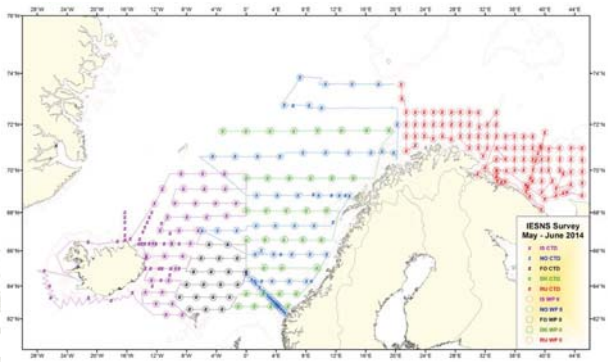
a) Develop an operational approach to integrated assessment of the Norwegian Sea;
b) Perform up to date integrated assessment for the Norwegian Sea ecosystem;
c) Utilize multispecies and ecosystem models to investigate effects of single and multispecies harvest control rules on fishing yield and ecosystem state for the purpose of developing ecosystem based advice;
d) Develop absolute abundance estimates of zooplankton and pelagic fish;
e) Develop sampling requirements for integrated assessment of the Norwegian Sea.
f) Consider the WKECOVER report and draft sections 1, 2 and 3 of an initial Ecosystem Overview for the Norwegian Sea.

Many participated in the work so far … and the list will grow

Name	Country	Expertise
Jan Arge Jacobsen	Faroese Islands	Fisheries biology/assessment
Anna Olafsdottir	Faroese Islands	Fisheries biology
Eydna i Hömrum	Faroese Islands	Fisheries biology/assessment
Hjalmar Hatun	Faroese Islands	Oceanography
Gudmundur Oskarsson	**Iceland**	**Fisheries biology/assessment – Co-chair**
Hildur Petursdottir	Iceland	Zooplankton
Geir Huse	**Norway**	**Fisheries biology, ecological modelling – Co-chair**
Anne Kristine Frie	Norway	Marine mammals, ecology, modelling
Hein Rune Skjoldal	Norway	Marine ecology, integrated assessment, zoopl.
Kjell Utne	Norway	Data analysis, modelling, fisheries biology
Erling Kåre Stenevik	Norway	Fisheries biology/assessment
Øistein Skagseth	Norway	Oceanography
Morten Skogen	Norway	Oceanography, biophysical modelling
Aril Slotte	Norway	Fisheries biology/assessment
Åge Høines	Norway	Fisheries biology/assessment
Are Salthaug	Norway	Fisheries biology/assessment
Leif Nøttestad	Norway	Fisheries biology/assessment
Gro van der Meeren	Norway	Ecology, integrated assessment
Petter Fossum	Norway	Zooplankton
Espen Bagøien	Norway	Zooplankton
Webjørn Melle	Norway	Zooplankton
Espen Strand	Norway	Zooplankton
Per Arneberg	Norway	Zooplankton

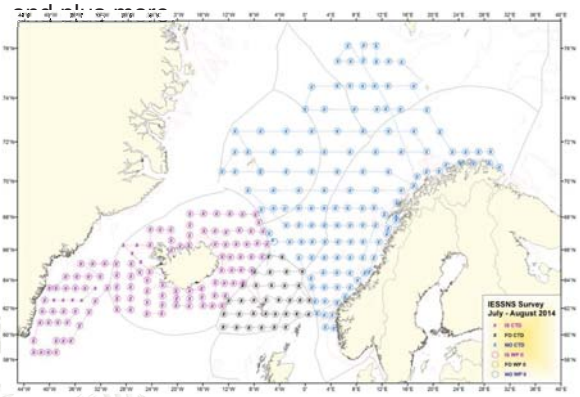
Key surveys

IESNS: Includes sampling in May during 1995-2014 on acoustic, pelagic trawling, WP2, MOCNESS, and CTD.



Key surveys

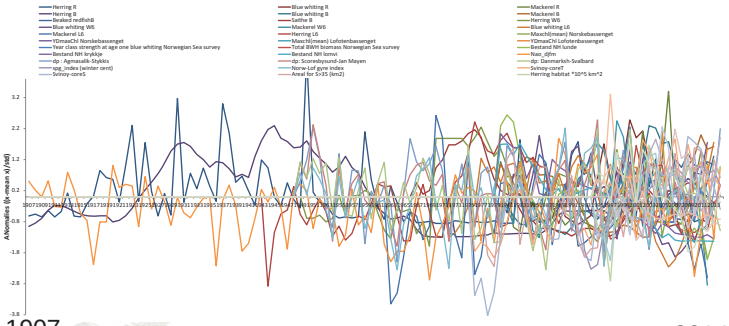
IESSNS: Includes sampling in July-August during 2007-2014 on acoustic, pelagic trawling, WP2, CTD and plus more



a) Current tool and method development ongoing on in your IEA group.

- Empirical approach based on 55 state variables (data assembly, data analysis, interpretation)
- PCA analysis
- Multispecies and ecosystem modelling (3D)

Anomaly plot for the 55 variables used to characterize the Norwegian Sea ecosystem. Standardized anomalies: (x-mean)/std

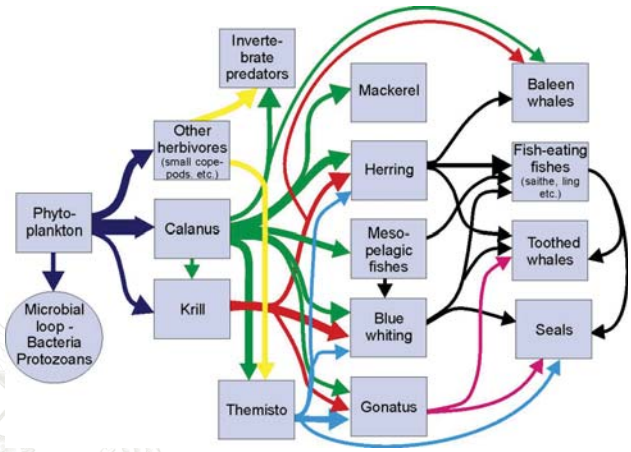


1907 2014

b) List any choices/prioritisation of ecosystem components/specific activities or pressures that have been made by your group

- Pressures: fisheries and climate change
- Plankton
- Fish biomass
- Oceanography

The Norwegian Sea ecosystem

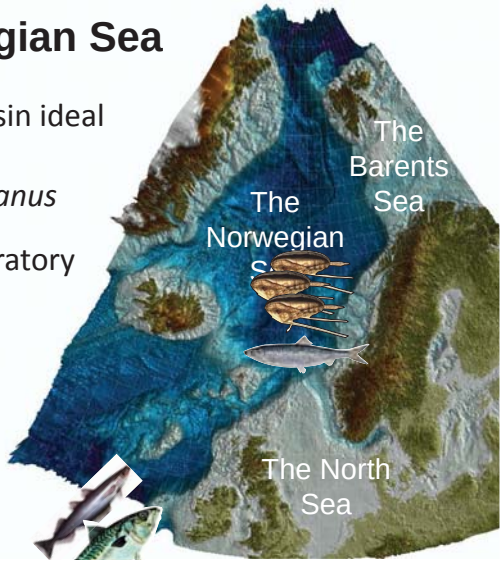


c) Highlight any case studies (areas, species, sectors) that have been chosen by your group

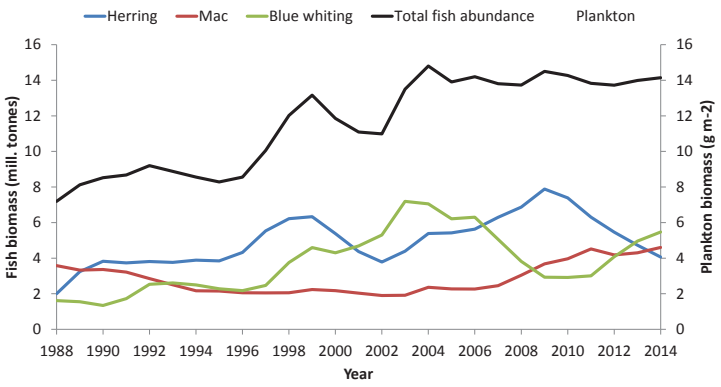
- Interactions between fish stocks and multispecies management of pelagic complex
- Co-occurrence of fisheries and climate and interactions between stocks

The Norwegian Sea

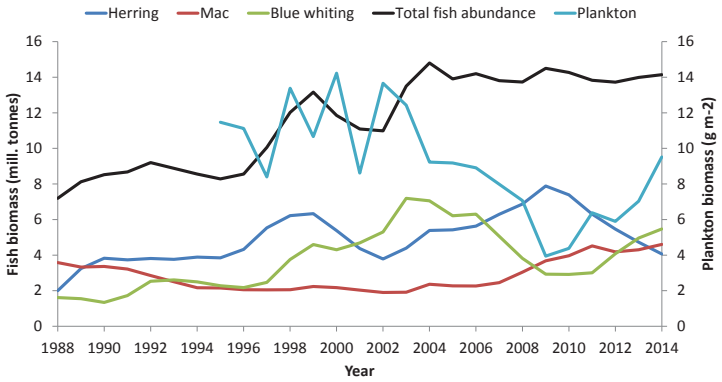
- Deep water basin ideal habitat for over-wintering of *Calanus*
- Utilised by migratory fish stocks:
  - **NSS herring**
  - **Blue whiting**
  - **Mackerel**



Fish and plankton

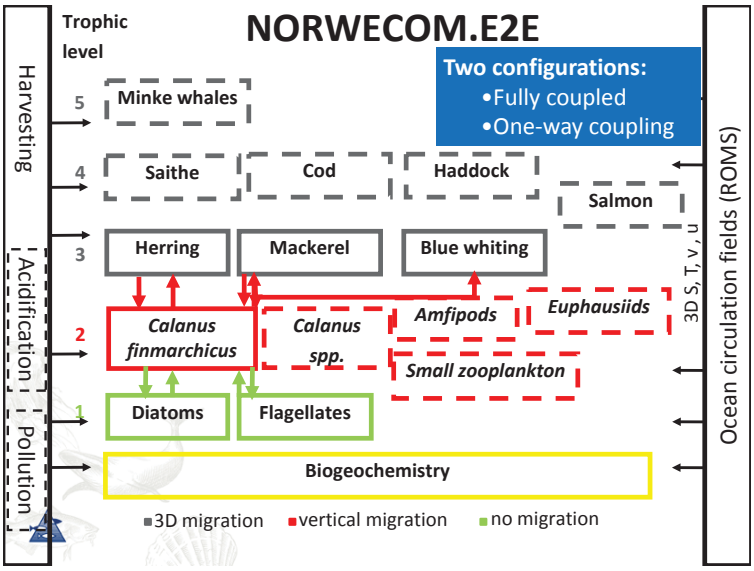


Fish and plankton



d) Tell us what you see as the key gaps and needs

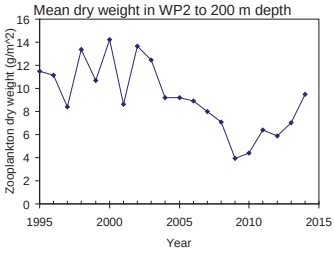
- Need more time! to analyse and systemise data
- Multivariate analysis
- More ecosystem modelling (3D)
- Gap in understanding makroplankton/micro nekton – but new trawl & acoustics promising

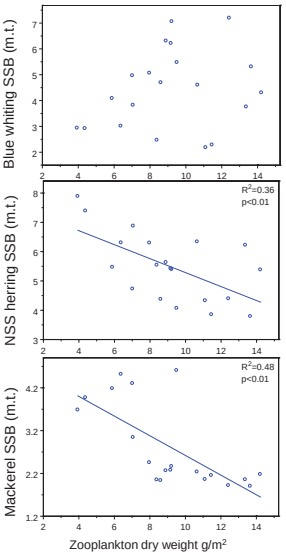


e) Describe how the group is planning to ensure open and traceable data approaches, quality assurance of products

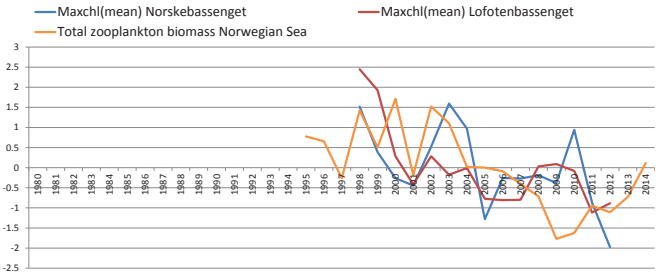
- Compiling common data set
- References to source data
- Publish data set as data papers?

Some preliminary analyses:





Indications for top-down forcing!

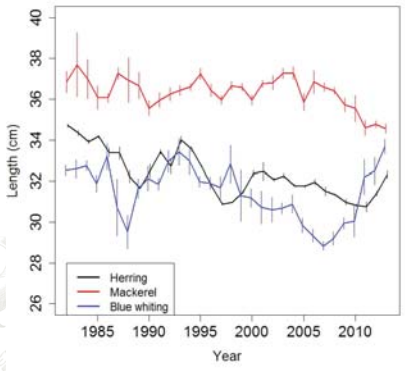


A weak positive correlation between zooplankton and chlorophyll a maximum.

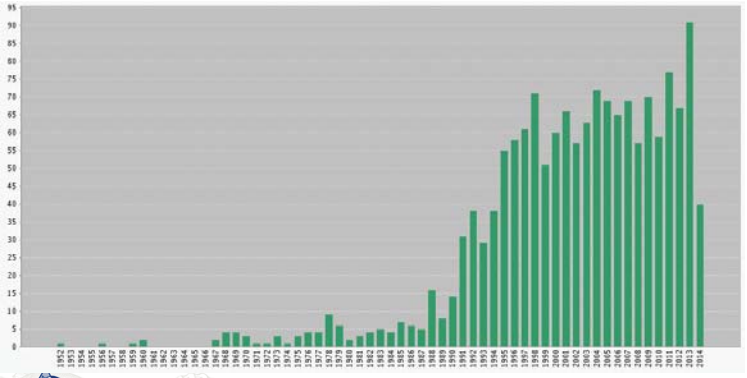
Could imply a bottom-up forcing ?

<u>Variation in growth rates of the pelagic fish stocks (length at age 6 in catch and survey data Oct-March):</u>

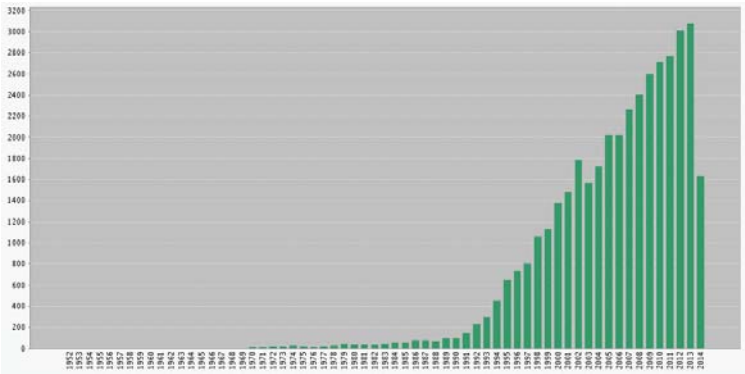
Density dependency, overgrazing, ecological factors (bottom up forces), interaction, others?



Published Items in Each Year on Norwegian Sea



Citations in Each Year on Norwegian Sea



WGCOMEDA

Working Group COMEDA

Comparative Analyses between Mediterranean and Atlantic marine ecosystems to move towards an Ecosystem-based Approach to Fisheries

Participants group photo of the WGCOMEDA meeting in Barcelona

Chairs:
Marta Coll
Manuel Hidalgo
Hilmar Hinz

WGCOMEDA

Current tool and method development ongoing within WGCOMEDA

The WG's aim is to further an in depth understandings of systems shaping processes using trans-regional **Atlantic-Mediterranean** comparative approaches.

We are aiming develop and/or utilize **system indicators** that are able to assess the sensitivity of systems to disturbance from **fishing** and **climate change**.

Three working topics embracing different organizational levels, population, community and ecosystem, are the central focus of the WG:

1. ***Key population traits and dynamics affecting community and ecosystem functioning***
2. ***The resilience – resistance trade-offs at different levels of biological organization (population-community-ecosystem) of fish***
3. ***Biodiversity and ecosystem traits changes at regional scales.***

Statistical and ecosystem modelling (ECOSIM/ECOPATH) techniques as well as meta-analytical techniques will be used.

WGCOMEDA

List any choices/prioritisation of ecosystem components/specific activities or pressures that have been made by your group.

The WG will focus on investigating the importance of **'forage fish'** species in this the Atlantic and Mediterranean ecosystems

'Forage fish' *within the context of the WG were defined to include benthic, demersal and pelagic fish that are prey of upper trophic level predators and transfer a large proportion of energy in the ecosystems*

Within a preliminary analyses, we will look at all the species efficiently captured in the IBTS. Other ecosystem compartments may be a focus at a later stage Atlantic and Mediterranean ecosystems comparison (i.e. benthos).

WGCOMEDA

Highlight any case studies (areas, species, sectors) that have been chosen by your group.

The philosophical and empirical framework of the group is to approach all the topics from an **Atlantic – Mediterranean** comparative approach.

At the moment, scientists from Iceland, Norway, Denmark, France, Germany, UK, Greece, Italy, Spain will cover around 15-18 systems from the Barents Sea to the Eastern Mediterranean.

Map showing the potential regional areas that may be included in system analysis

WGCOMEDA

Tell us what you see as the key gaps and needs

Knowledge gaps and needs:

While within regional seas exceptional knowledge of ecosystem exists a **synthesis across** the two distinct systems, i.e. Atlantic and Mediterranean is still lacking.

Ecological processes may function differently at the regional scale levels and by contrasting these the knowledge gained may provide fundamental ecological understanding to **EBAF** and **IEA**.

Operational gaps and needs of the WG:

Funding is currently a key restriction. The group was founded in an attempt to be a balanced combination of experienced and **early-career scientists** . Thus a key requirement for the group is to secure funding for the attendance of young enthusiastic scientists.

Finally, WGCOMEDA is the first scientific activity established after the **Memorandum of Understanding (MoU)** signed between **ICES** and **GFCM**, and an underlying need of the WG is the continuous support for these collaborative activities by both organisations.

WGCOMEDA

Describe how the group is planning to ensure open and traceable data approaches, quality assurance of products.

All research topics proposed in the WG are envisioned as scientific publications within **peer reviewed journals**.

All the **methodological approaches developed** will be provided as supplementary material in the journals as well as in the ICES reports.

Data traceability and **open availability** will depend upon **regional restrictions** and thus the WG is not intended to pursue towards an open availability of all the information analysed.

WGIBAR
Working group on the integrated ecosystem assessment of the Barents Sea

Presentation by co-chair Edda Johannesen (IMR, Norway)
for

Workshop on Regional Seas Commissions and Integrated Ecosystem Assessment Scoping (WKRISCO)
København 17.-18. November 2014

HAVFORSKNINGSINSTITUTTET
INSTITUTE OF MARINE RESEARCH

WGIBAR:

Chairs:

- Yuri Kovaljev (PINRO, Russia)
- Edda Johannesen (IMR, Norway)
- First meeting: March 2014

  5 partipants from PINRO

  7 particpants from IMR

Outline:

- Short description of the Barents Sea
- Answer questions provided by WKRISCO

  a) current tool and method development ongoing on in your IEA group

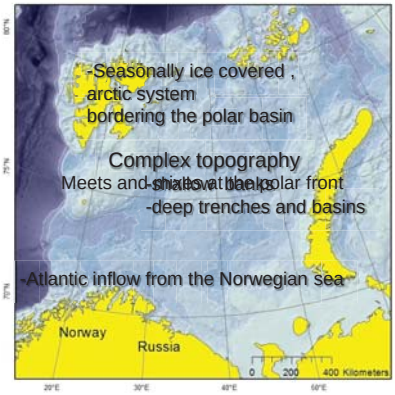
  b) list any choices/prioritisation of ecosystem components/specific activities or pressures that have been made by your group

  c) highlight any case studies (areas, species, sectors) that have been chosen by your group

  d) tell us what you see as the key gaps and needs

  e) describe how the group is planning to ensure open and traceable data approaches, quality assurance of products.

The Barents Sea



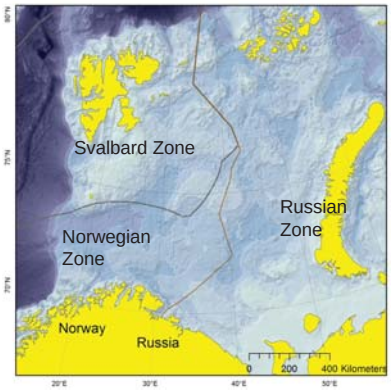
•Large Marine Ecosystem
~1.8 million km^2

•Shelf sea
mean depth ~230 m

•High latitude
~70° to 80° N

Arctic and Atlantic water masses => Arctic and Atlantic/boreal species
Large scaled seasonal migrations connects the Atlantic and Arctic sub-systems

The Barents Sea



•Sparsely populated region:
Murmansk: 300 000
Norwegian cities: 30 000

•Sustain some of the largest fisheries in the world:
- Cod, haddock
-Capelin (pelagic)
- other includes shrimp, greenland halibut etc

b) list any choices/prioritisation of ecosystem components/specific activities or pressures that have been made by your group

•Climate change and variability
•Fishing = most important human pressure

1/3 WGIBAR –members part of AFWG
Close cooperation between AFWG and WGIBAR
- Recomended by WKBEMIA (2013)

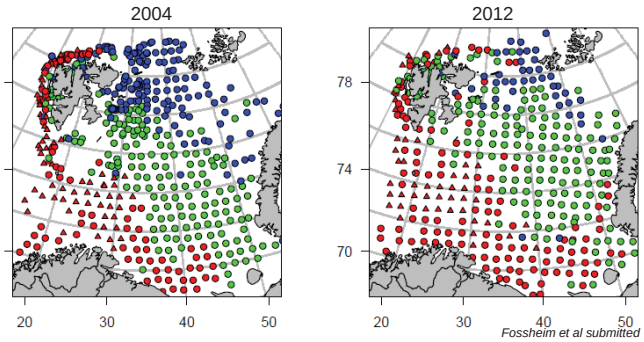
c) highlight any case studies (areas, species, sectors) that have been chosen by your group

From the first WGIBAR interim report:

1. The last decade has been the warmest on record. During the last 30–40 years there has been a general warming in the BS whereas before this there was a general cooling. Will there be a long-term cooling trend in the BS soon, and how cold will the BS then become?
2. What will happen with the BS stocks if the BS cools?
3. Are there different optimal levels of exploitation of commercially important species in "cold" and "warm" periods / different productivity regimes?
4. What is the carrying capacity of the BS for planktivorous and piscivorous species including fish, seabirds and seamammals in cold and warm periods?
5. Most of the stocks in the BS are large and well managed, but could the management be further improved if we take ecosystem considerations more into account?
6. The cod stock is very large, if cod becomes food limited, should the fishing pressure on cod be increased? (Or decreased?)
7. Cod has been moving further north/north-eastwards in the main feeding season every year since 2004 – is the movement driven by food limitations?
8. The cod stock is one of the most profitable stocks in the BS and the current strategy is to aim for a maximum catch of cod and to take the catch other fish as a "residual" after cod consumption.
   a. What is the cost (loss of catch of other species) of having a large cod stock?
   b. How would alternative harvesting strategies of cod change the biomass of stocks of other commercial species and their MSY?
   c. How would different harvesting strategies affect the rest of the ecosystem?
9. Capelin is moving north-eastwards - is the movement driven by food limitations?
10. Why has the condition and weight-at-age of capelin decreased the last five years or so?
11. What is driving the variability of jellyfish biomass, and will the observed increase in jellyfish impact 0-group fish or other planktivores?
12. Will an increase in the invasive snow crab affect the shrimp stock or other species?

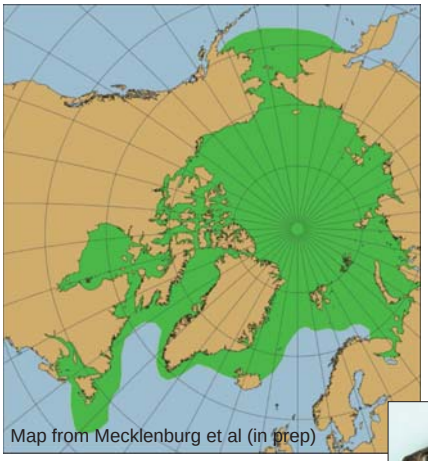
c) highlight any case studies (areas, species, sectors) that have been chosen by your group

Focus on Arctic species?



Fossheim et al submitted

Blue: fish community dominated by Arctic species has been reduced

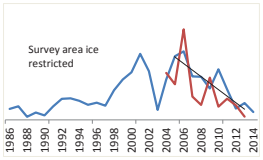


Map from Mecklenburg et al (in prep)

Polar cod

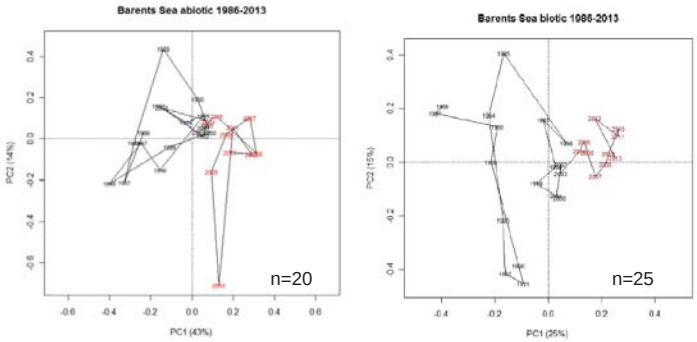
(*Boreogadus saida*)

- Arctic, ice associated
- Circumpolar distribution
- Pelagic and mainly planktivour
- Abundant => important link in the Arctic food web



a) current tool and method development ongoing on in your IEA group

Compile time series
Integrated trend analysis

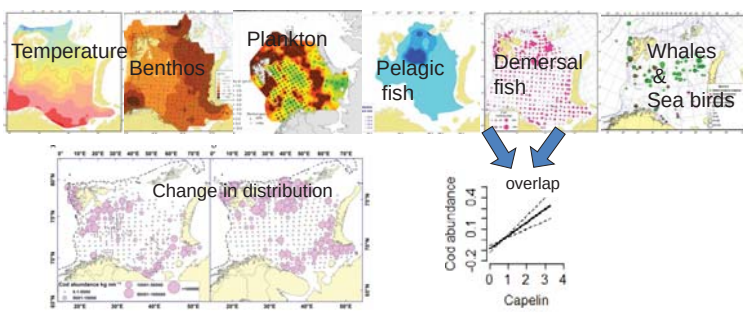


Red: 2004-2013

From WGIBAR report 2014

a) current tool and method development ongoing on in your IEA group

Joint IMR PINRO Ecosystem survey : 2004 – present
=> develop spatial indices: changes in distribution & overlap (?)



Kjesbu et al 2014

Johannesen et al 2012

d) tell us what you see as the key gaps and needs

1) Data rich and well researched but:
- Lack time series data on some key components (e.g. benthos), data sparser back in time, e.g. spatial data

2) Despite large, unprecedented changes
– a continuous demand to reduce the monitoring effort

3) Rapid, unprecedented changes
– lack time, capacity, resources to understand the changes

e) describe how the group is planning to ensure open and traceable data approaches, quality assurance of products

Most data we use are from published reports

Data sets can be published as data papers
eg with each final report every third year

Thanks for the attention!

The Integrated Assessment as the main goal for achieving an Ecosystem Approach to Management in the Western European Shelf Seas

Eider Andonegi, Stephen Beggs, Fatima Borges, Pascal Laffargue, Marcos Llope, Nogueira, Enrique & Dave Reid

WGEAWESS

ICES Working Group on Ecosystem Assessment of Western European Shelf Seas

ToR a) Metadata compilation for ODEMM analysis (2y)

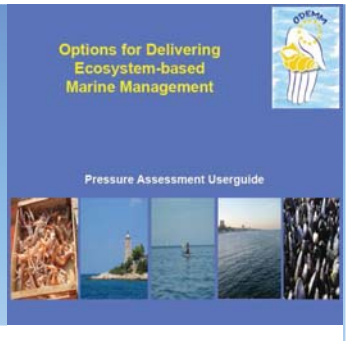
ToR b) Preliminary evaluation of data and trends (3y)

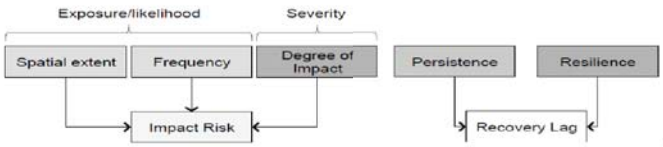
ToR c) Ecosystem overviews (3y)

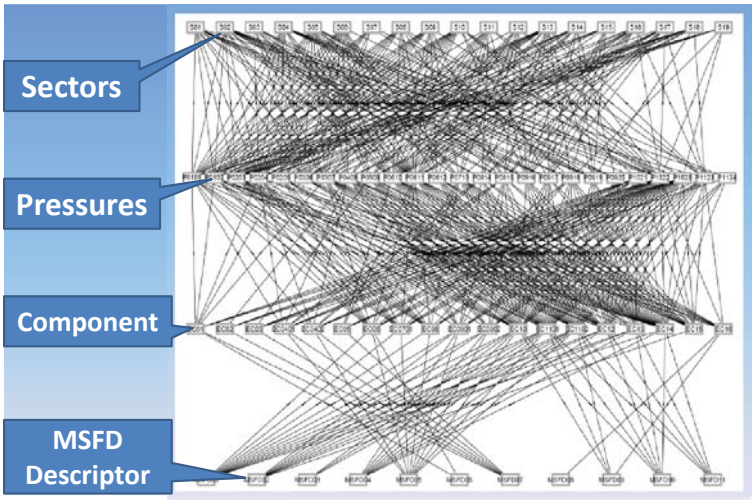
ToR d) Identify ecosystem trends and linkages (ongoing)

WGEAWESS Current Tools

- ODEMM Approach
- Sectors
- Pressures
- Components

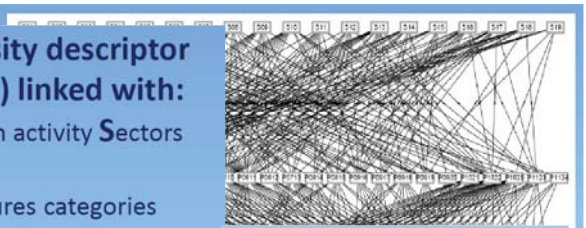


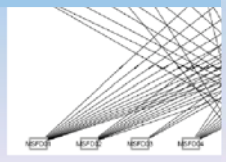




Biodiversity descriptor (MSFD01) linked with:

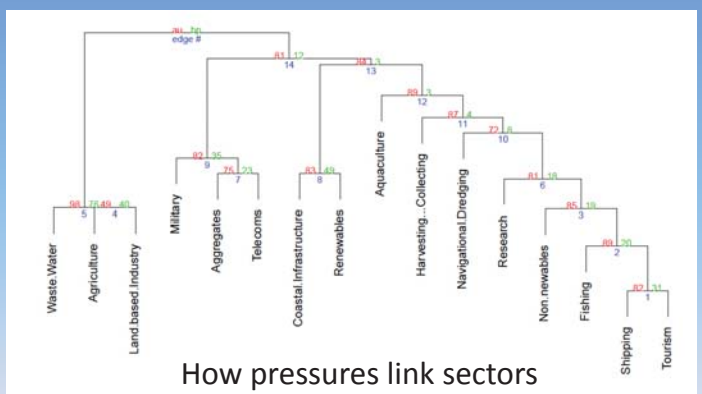
- **19** human activity **S**ectors (S, level 1)
- **25 P**ressures categories (P, level 2)
- **11 E**cosystem **C**omponents (EC, level 2)





Foodweb descriptor (MSFD04) linked with:

- **19** industry **S**ectors (S, level 1)
- **25 P**ressures categories (P, level 2)
- **8 E**cosystem **C**omponents (EC, level 2)



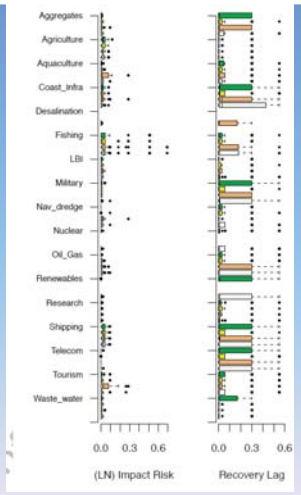
How pressures link sectors

WGEAWESS Choices
Of ecosytem components/sectors/pressures

- Based on analysis results

WGEAWESS Choices
Of ecosytem components/sectors/ pressures

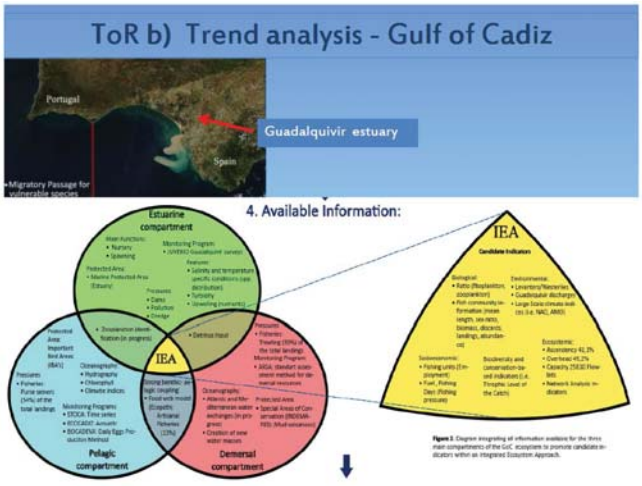
- Strong impact risks
- Slow recovery lag



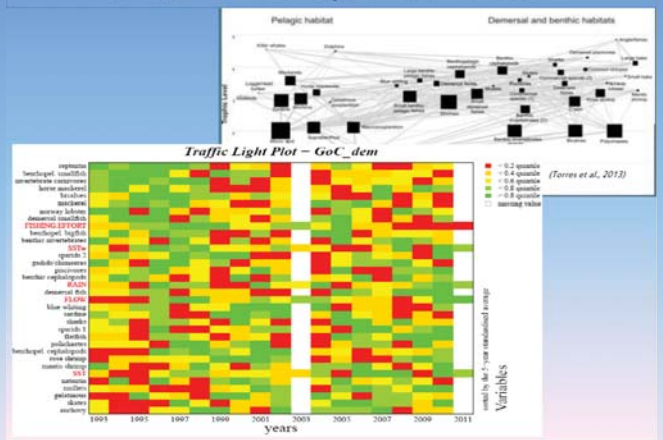
WGEAWESS Choice of case study Areas/species/sectors

- Celtic Sea, Irish Sea, Biscay, Cantabrian Sea, Gulf of Cadiz
- Predominantly fish species on basis of data
- Fishing probably main sector

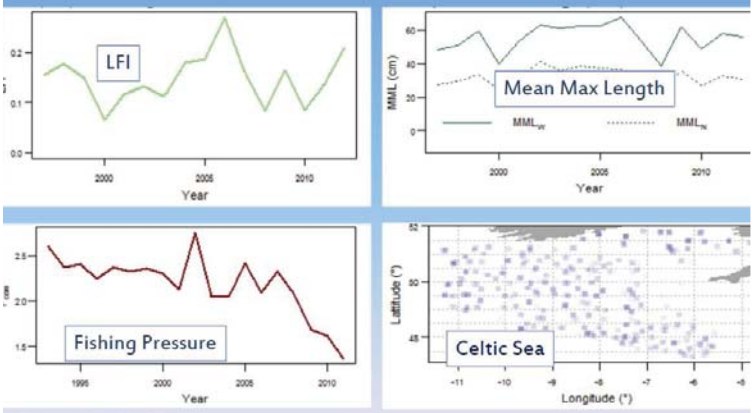
ToR b) Trend analysis - Gulf of Cadiz



ToR b) Trend analysis - Gulf of Cadiz



ToR d) MSFD D4 Foodwebs – LFI & MML



WGEAWESS Indicator Trends

Celtic Sea – sensitive species

Species must have:

1. **≥5 individuals km2 pa ,AND**
2. **≥2 years and ≥5% of all hauls.**

Trenkel and Cotter (2009)

- **73 species: 24 resilient, 23 intermediate & 26 sensitive**
- **Visual Trends for proportion larger than Lmat:**
- **7 up, 4 down, 8 no trend, 7 insufficient data**

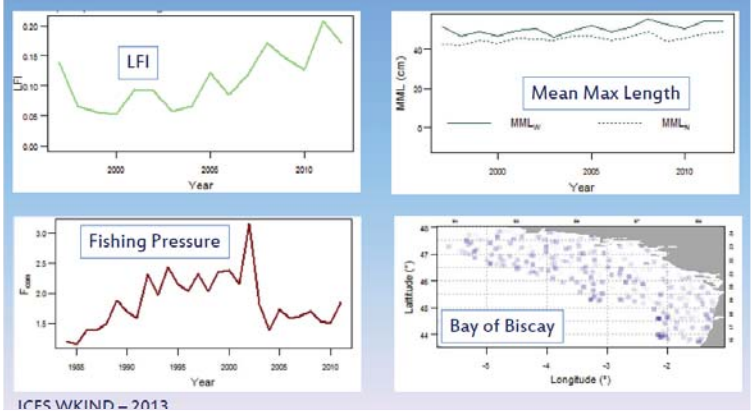
WGEAWESS Key Gaps and Needs

- **Key Gaps – dependent on area. E,g in Celtic Sea – Eutrophication, pollutants, marine mammals, seabirds, benthos, plankton**
- **Key gaps – expertise beyond fisheries based ecosystem skills.**

ToR d) Proposed indicators to assess GES in pelagic habitats for descriptors D1 and D4 based on plankton components - NW and N Spanish shelf

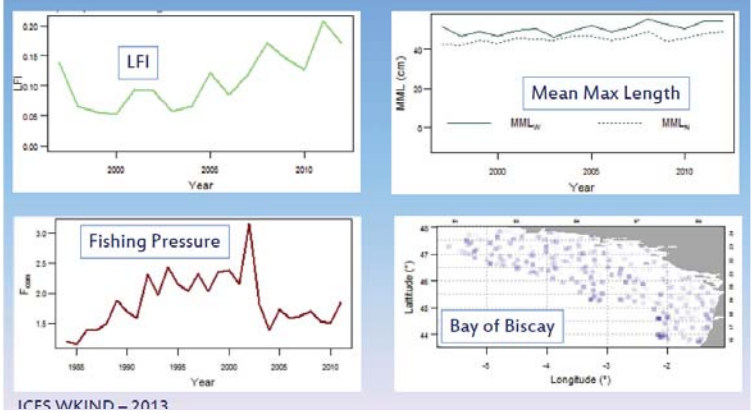
- **HP/RT-Life-form.** Changes in life-form (functional groups) pairs (OSPAR-PH1)
- **HP-Abundance.** Abundance / Biomass of plankton components (OSPAR-PH2)
- **HP-Biodiversity.** Diversity indices for plankton components (OSPAR-PH3)
- **RT-Phytoplankton.** Phytoplankton production (OSPAR-FW2)
- **RT-Zooplankton.** Abundance, biomass, species composition and spatial distribution of zooplankton (OSPAR-FW6)

ToR d) MSFD D4 Foodwebs – LFI & MML



ICES WKIND – 2013

ToR d) MSFD D4 Foodwebs – LFI & MML

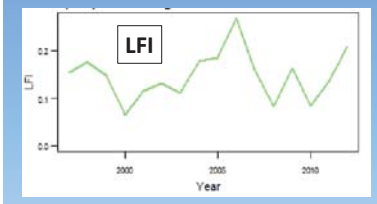


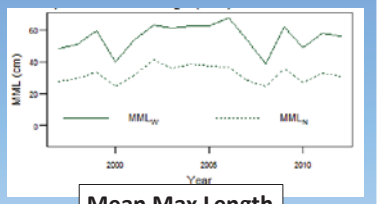
ICES WKIND – 2013

WGEAWESS Terms of Reference

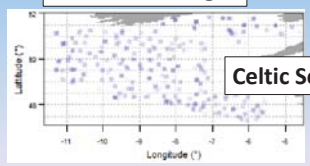
- Metadata compilation for ODEMM analysis
- Preliminary evaluation of data and trends
- Ecosystem overviews
- Identify ecosystem trends and linkages

WGEAWESS Indicator Trends
MSFD D4 Foodwebs – LFI & MML



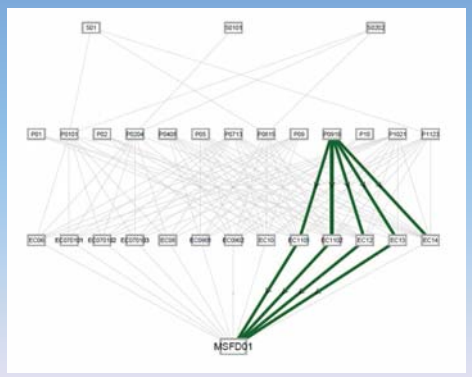


Mean Max Length



Celtic Sea

WGEAWESS ODEMM Analysis
MSFD D1 Biodiversity Biscay

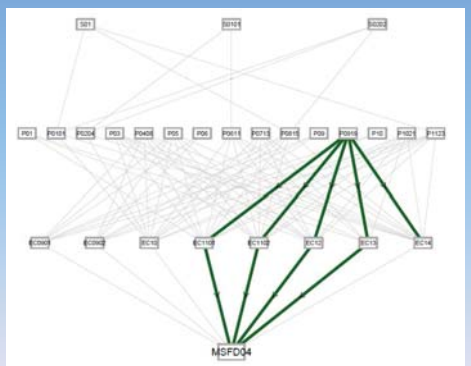


Two main sectors:
- Aquaculture & Benthic trawls

Main pressure with data:
- Death or injury by collision

Linked components:
- Demersal Fis
- Pelagic Fish
- Mammals and Reptiles
- Seabirds
- Listed species

WGEAWESS ODEMM Analysis
MSFD D4 Foodwebs



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