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Report of the Workshop to Define the Ocean Observing Needs for ICES (WKOOI)

29 February-2 March 2012

ICES Secretariat, Copenhagen, Denmark

ICES International Council for the Exploration of the Sea

CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The general aim of the workshop was to determine whether ICES needs a more coordinated Ocean Observing effort? And if yes, what does this effort look like and what steps are needed to make it happen?

The specific goals are 1) to develop a clear conclusion to pass onto SCICOM regarding the questions above and 2) to end with a draft report that is almost ready for submission to ICES.

First, the workshop participants determined that ICES definitely needs a more coordinated approach. Second, a framework for an ICES ocean observing strategy was developed. This framework recognizes ICESs role in developing single-species and ecosystem-based assessments. The information challenges to support these products are daunting. Seven activities were identified: data collection, data management, coordination, integration and analysis, assessments, communication, and new technologies. The general needs for each activity were identified. This framework was sent to SCICOM for comment and subsequently changed to address these comments. The final version is provided in Annex 5.

Several next steps are defined. First, a WG is proposed to take this framework and develop a detailed strategy. This WG may focus on only a subset of the defined activities. Second, SCICOM needs to develop a governance structure for reviewing and making recommendations for changes to the observing systems in the North Atlantic. In this regard, ICES is a user of ocean observing information and must become actively involved in developing an adaptive observing system that is applicable to changing needs and authorities, as well as to new technologies and understandings.

1 Opening of the meeting

The Workshop to Define the Ocean Observing Needs for ICES (WKOOI) was held at ICES Headquarters in Copenhagen and co-chaired by Jon Hare (USA) and David Mills (UK). WKOOI met on 29 February to 2 March. There were 18 participants (Annex 1); most met in person, but several used WebEx. J. Hare and D. Mills opened the meeting with a review of the agenda and the workshop goals. The meeting then address the ToRs and defined and drafted workshop products.

2 Adoption of the agenda

The proposed agenda was approved (Annex 2) and J. Hare acted as rapporteur for the workshop. In addition, audio from the workshop was recorded and this was used in the development of WKOOI products.

3 Terms of Reference (ToRs)

Terms of Reference

a) Review ICES Observation products and systems, in relation to present and potential future scientific advice needs of ICES and ICES member nations **(WHAT OCEAN OBSERVATIONS ARE NEEDED BY ICES)**

b) Broadly define ocean observing needs, relative to variable, platform, time and space scales, and the role of ICES in fulfilling needs **(WHAT OCEAN OBSERVATIONS ARE NEEDED BY MEMBER NATIONS)**

c) Review ICES Ocean Observing activities through review of EG reports **(WHAT DOES ICES DO)**

d) Review outside (non-ICES) observing activities in the North Atlantic and define any that are used in ICES advice products **(WHAT IS GOING ON OUTSIDE ICES IN THE ATLANTIC)**

e) Review IOC GOOS frameworks and define what ICES can provide to GOOS and other global coordination initiatives **(WHAT IS HAPPENING AT THE INTERNATIONAL LEVEL)**

f) Draft list of recommendation for ICES – potential EG proposal, potential products **(WHAT SHOULD ICES DO)**

3.1 Review ICES Observation products and systems, in relation to present and potential future scientific advice needs of ICES and ICES member nations (ToR a)

Henrik Sparholt reviewed the advisory products currently produced by ICES. Most are categorized as single-species assessment advice. However, a need for regional ecosystem information was identified to provide a broader framework within which to develop single species advice; this concept is generally termed Ecosystem-Based Fisheries Management (EBFM). Also, examples were given of the use of environmental and ecosystem information directly in single-species stock assessments. Advice classified as Ecosystem Based Management (EBM) is also developed by ICES and in general, the need for this type of advice will grow (e.g. Marine Strategy Framework Directive). ICES needs to continue single-species advice while also increasing Ecosystem Based Fisheries Management and Ecosystem Based Management Advice.

The efforts of WGOOFE and WGISUR were also reviewed. WGOOFE has produced a review of the environmental data needs for ICES advice (http://www.tos.org/oceanography/archive/24-1_berx.html). They identified a potential mismatch between user requirements and the perception of requirements by the providers. This finding argues for more communication and more collaboration between observing systems and living marine resource scientists.

WGISUR has considered the role of surveys in supporting EBFM and EBM (http://www.ices.dk/reports/SSGESST/2012/WGISUR12.pdf). They defined a number of specific steps that could be taken to collect data in support of EBFM and EBM while continuing to collect data in support of single species assessments.

3.2 Broadly define ocean observing needs, relative to variable, platform, time and space scales, and the role of ICES in fulfilling needs (ToR b)

Large ocean observing efforts were reviewed: EuroGOOS, DFO, and IOOS. These large efforts are in one way or another part of GOOS. The observing capabilities are remarkable and the potential for contributing to single-species management, EBFM, and EBM is tremendous. The work of WGOOFE serves as an excellent example. The general objectives of these systems are largely similar, in part resulting from their relationship with GOOS and in part because of the common needs shared by countries across the ICES community. They typically list living marine resource and ecosystem-based management as one 'user'

3.3 Review ICES Ocean Observing activities through review of EG reports (ToR c)

68 of the 2011 WG and SG reports were reviewed for the contribution to ocean observing and their need for ocean observing data. Many of the ICES groups contribute to ocean observations but are not part of GOOS or IOOS. In addition, many of the group could benefit from additional ocean observing activities and have major management needs. Finally, many of the groups expressed the need for increased communication and coordination with ICES. One point that was striking was the diversity of biological observations and data collected represented among the ICES groups. This emphasis on observing of Living Marine Resources is complementary to the physical emphasis of many ocean observing efforts (Figure 1).

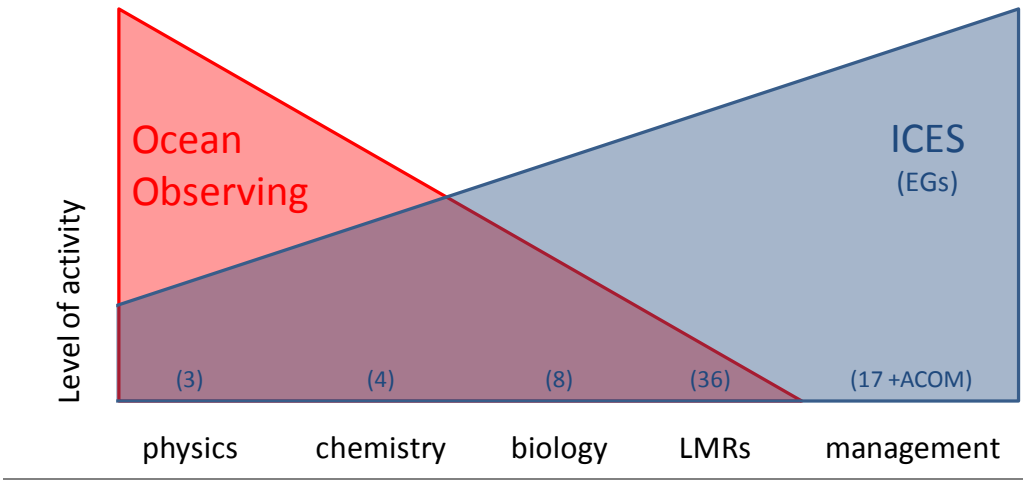

Figure 1. Categorization of observing activities by ICES Working and Study Groups. Number of groups working on a particular category are provided (n).

In addition to this review, a number of participants presented the activities of ICES WG's or of their institutions. Again, ICES capabilities for observing biological components of the ecosystem are remarkable. Also, ICES and ICES member nation's are leading the development of new technologies for use in biological observing. ICES also leads physical and chemical observing across the North Atlantic with the ICES Report on Ocean Climate as the standout example (http://www.ices.dk/pubs/crr/crr309/ICES%20SCREEN%20PDFs/ICRR%20309-inner-singles.pdf). A unique aspect of living marine resource observing is the need for ships to sample animals. This access to shiptime is a highly valuable resource.

The activities of the ICES Data Centre were also reviewed. The capabilities are tremendous and these resources need to be communicated more broadly though the scientific community.

3.4 Review outside (non-ICES) observing activities in the North Atlantic and define any that are used in ICES advice products (ToR d)

A list of activities ongoing outside ICES was developed prior to WKOOI and then reviewed (Annex 6). This list is incomplete. Collectively, these activities contribute to an understanding of the North Atlantic ecosystem. In the development of single-species management, EBFM and EBM, information collected outside ICES may be crucial and thus, ICES needs to include partnerships and collaboration in the ocean observing strategy.

3.5 Review IOC GOOS frameworks and define what ICES can provide to GOOS and other global coordination initiatives

Henrik Enevoldsen attended from IOC and presented an update of GOOS. In 2011, IOC resolved to strengthen and streamline GOOS (http://www.unesco.org/new/en/media-services/single-view/news/ioc_assembly_resolves_to_strengthen_and_streamline_goos/). Based on this effort there is an opportunity for ICES to contribute and coordinate its observing efforts with those of GOOS. Two GOOS objectives are: i) describe and forecast the state of the ocean, including living resources, and ii) improve management of marine and coastal ecosystems and resources. These objectives are closely allied with ICES goals. Participants discussed the need to interact with GOOS similar to the need to interact with other observing efforts in the North Atlantic. ICES through WGOOFE already has strong ties with EuroGOOS and this can be used as an example for benefits to ICES from collaboration and partnership.

3.6 Draft list of recommendation for ICES – potential EG proposal, potential products (ToR f)

Two main products were developed as an outcome to this workshop. First, a white paper was produced that develops the framework for an ICES Strategy for Ocean Observing (Annex 5). This was submitted to SCICOM, comments were received, changes made and the final form is presented here. Second, a powerpoint based on the white paper was developed. The purpose of this was so that the results of WKOOI could be presented to WG meeting later in March 2012 (WGOH, WGIPEM). The PowerPoint is available upon request.

In addition, two legacy activities were defined. First, a WG should be formed to develop a detailed strategy based on the framework developed during WKOOI. Second, SCICOM needs to consider the long-term governance of a distributed ocean observ-

ing system in support of ICES products; distributed meaning that some of the data used in ICES products may not be collected within the ICES community.

Annex 1: List of participants

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Annex 2: Agenda

Workshop to Define the Ocean Observing Needs for ICES (WKOOI)

DAY 1

Date	ToR	Start Time	Duration	Topic	Lead	Content
29-Feb		9:00	10.00	Logistics	Chairs	10 min summary
		9:10	10.00	Introductions	Chairs	10 min introductions
		9:20	30.00	Why are we here?	Jon Hare	20 min presentation / 10 min discussion
	ToRa	9:50	30.00	Overview of ICES Advice	Henrik Sparholt	20 min presentation / 10 min questions
	ToRa	10:20	20.00	Summary of WGOOFE Survey	Patrick Gorringe	15 min presentation / 5 min questions
	ToRa	10:40	20.00	Summary of WGISUR Survey	Dave Reid	15 min presentation / 5 min questions
	ToRa	11:00	20.00	Summary of WKOOI Survey	Jon Hare	15 min presentation / 5 min questions
	ToRa	11:20	40.00	Discussion of ToRa	Chairs	40 min discussion
		12:00	90.00	LUNCH	LUNCH	LUNCH
	ToRb	13:30	30.00	Canadian Review	Catherine Johnson	20 min presentation / 10 min questions
	ToRb	14:00	50.00	European Review	David Mills	40 min presentation / 10 min questions
	ToRc	14:50	30.00	ICES Data Center Overview	Hjalte Parner	20 min presentation / 10 min questions
		15:20	40.00	BREAK	BREAK	BREAK
	ToRb	16:00	30.00	U.S. Review	Hassan Moustahfid	20 min presentation / 10 min questions
	ToRc	16:30	20.00	Review of EG Reports	Jon Hare	15 min presentation / 5 min questions
	ToRb/ToRc	16:50	60.00	Discussion of ToRb and ToRc	Chairs	60 min discussion
		17:50		END OF DAY	END OF DAY	END OF DAY

Workshop to Define the Ocean Observing Needs for ICES (WKOOI)

DAY 2

Date	ToR	Start Time	Duration	Topic	Lead	Content
1-Mar	ToRc	9:00	30.00	WGOH Activities	Anna Akimova	20 min presentation / 10 min questions
	ToRd	9:30	30.00	WGZE Activities	Mark Benfield	20 min presentation / 10 min questions
	ToRd	10:00	10.00	Canadian Obs	Catherine Johnson	10 min presentation / discussion
		10:10	30.00	Marine Ecosystem Acoustics	Olav Rune Godø	20 min presentation / 10 min questions
	ToRe	10:40	60.00	Overview of GOOS	Henrik Enevoldsen	30 min presentation / 30 min discussion
	ToRe	11:40	30.00	Overview of MONITOR	Jon Hare	20 min presentation / 10 min questions
		12:10	90.00	LUNCH	LUNCH	LUNCH
		13:40	90.00	Discussion - ToRa, ToRb, ToRc	Chairs	120 min discussion
		15:10	30.00	Review List of Activities - ToRd	Chairs	30 min discussion
		15:40	30.00	BREAK		
		16:10	60.00	Discussion - ToRe	Chairs	60 min discussion
		17:10		END OF DAY	END OF DAY	END OF DAY

Workshop to Define the Ocean Observing Needs for ICES (WKOOI)

DAY 3

Date	ToR	Start Time	Duration	Topic	Lead	Content
2-Mar	ToRf	9:00	180.00	Discussion - Strategies for Moving Forward	Chairs	180 min discussion
		12:00	90.00	LUNCH	LUNCH	
		13:30	180.00	Report Drafting	Chairs	180 min discussion
		16:30	30.00	Closing Remarks	Chairs	
		17:00		END OF DAY	END OF DAY	END OF DAY

Annex 3: WKOOI Terms of Reference for the next meeting

The **Workshop to Define the Ocean Observing Needs** for ICES completed its work. The activities addressed by WKOOI will need to be continued by another WG and with oversight by SCICOM.

Annex 4: Recommendations

Recommendation	For follow up by:
1. ICES needs a more coordinated approach to ocean obsering	ICES
2. Establish a WG with ToRs that lead to develop a detailed ICES Stragety on Ocean Observing. The strategy was framed by WKOOI in the form of a White Paper submitted to SCICOM	ICES
3. SCICOM take the role of governance over the Ocean Observing Strategy directing the strategy and reviewing the effort iteractively.	ICES – SCICOM

Annex 5: An ICES strategy for ocean observing in support of marine resource management: a way forward

Introduction

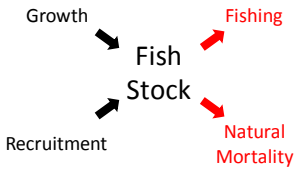
ICES has led the scientific research into the dynamics of fish populations starting with Johan Hjort who postulated that population dynamics were driven by variability of recruitment. The processes controlling recruitment have remained a central focus of fisheries research to this day, both inside and outside ICES. ICES also has contributed heavily to the conceptual model of fish population dynamics: fish populations increase through recruitment and growth and decrease through fishing and natural mortality. This conceptual model (see Box 1) and the theory of maximum sustainable yield [replaced by the similar optimum sustainable yield] form the foundation for current fisheries management.

Based on this single-species conceptual model, ICES has encouraged and coordinated science in support of resource management for more than 100 year. This science includes research, observing, modelling, and assessment of fishery stocks, as well as research, observing, modelling and assessment of the physical, biological, and chemical environment that support fisheries. Currently, ICES provides much of the stock assessment advice for European countries and this advice is science based, peer-reviewed, transparent, and standardized. To produce this advice, ICES and member countries coordinate an ocean observing system that estimates relative abundance, growth, and maturity, as well as fisheries catch and fishing effort. As an example, the International Bottom Trawl Survey coordinated through ICES combines the efforts of 12 countries to provide fishery-independent information for the use in stock assessments. These systems were and remain largely ship-based owing to the need to catch fish for identification, aging, and reproductive studies. As new techniques have become available, ICES has been involved in their incorporation into the observing system: egg surveys to provide data for the daily egg production method, acoustic surveys converting backscatter to abundance, and the more mundane migration from paper to electronic logs and manual to electronic measurements. The current observing systems supporting the single species conceptual model are very well established and have developed over decades with numerous improvements and adjustments

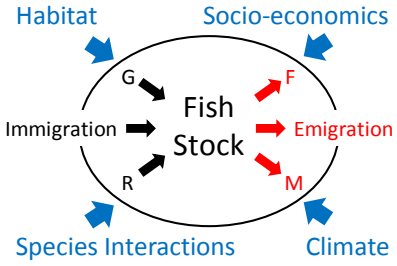
Over the past several decades there have been numerous calls to replace the standard single species model of fish population dynamics with a more integrative model that also includes spatial dynamics (immigration/emigration), species interactions, climate effects, habitat factors, and socio-economics (Box 1). This approach is often termed Ecosystem Based Fishery Management (EBFM). One reason for this change is the observation that some collapsed stocks did not rebuild even when fishing was reduced (e.g. northern Atlantic cod in Canada, North Sea herring). The inference from this observation is that factors other than fishing are important to stock dynamics. Another reason for this change is the realization that ecosystems and climate are ever changing and that the concepts of equilibrium and stationarity are rarely realized in nature. In particular, the threat of climate change and ocean acidification raises the potential for novel environmental conditions to be experienced in future; conditions that will likely change the dynamics of fishery resources and ecosystem. There also has been movement toward even more integrated ocean management termed Ecosystem Based Management (EBM), which considers numerous sectors simultaneously (e.g. fishing, energy, transportation). This idea engenders holistic management of marine ecosystems with a goal of maintaining healthy, productive and resilient conditions (Box 1). ICES has experience in EBM including support for the Convention for the Protection of the Marine Environment of the Northeast Atlantic (OSPAR Convention), the Helsinki Commission (HELCOM), and the Marine Strategy Framework Directive (MSFD), as well as expert groups examining wind energy, contaminants, and marine planning and coastal-zone management. ICES will need to continue to develop science in support of EBM and better integrate its fisheries work with the more holistic approach EBFM and EBM.

Box 1. Conceptual models of fish population dynamics.

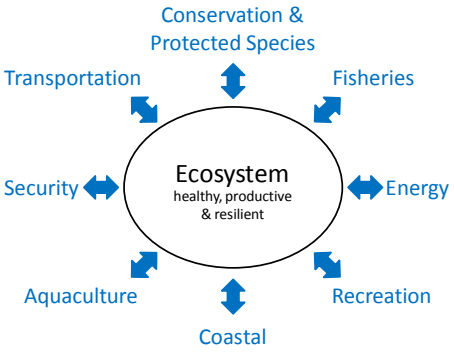
Single-species conceptual model



Ecosystem-based approaches to fisheries management conceptual model



Ecosysem-based approached to management conceptual model



Although the scientific need for a shift to EBFM and EBM has been identified, and the legal mandates for such a shift exists in the European Union and numerous ICES member nations, there remain legal mandates for single-species assessments, both in the context of fisheries management and protected species management. 95% of the advice provided by ICES in 2011 was single species advice. Thus, ICES needs to support the developing EBFM and EBM, while maintaining and continuing to improve the support for single species assessments.

Here we broadly address the ocean observing systems that will be needed in future to support single species, EBFM, and EBM. First, we define an ocean observing vision for ICES, then identify the components of this vision, and end with a brief discussion of the short, medium, and long-term actions needed to realize this vision. These ideas and actions were framed at the Workshop to Define the Ocean Observing Needs for ICES and will be developed in more detail over the next 18 months in an Ocean Observing Strategy.

Vision Statement: Maintain, improve, and develop ocean observing systems in support of current and future ICES assessments and products (see Box 2 for Definitions).

This vision statement recognizes that ICES will need to maintain observing systems to support current activities including single species management. As new technologies emerge or existing technologies advance, these will need to be incorporated into ongoing observing activities to improve the data collected for use in ICES activities. Finally, there is the need to develop observing systems to support EBFM and EBM. These new systems must be connected to specific assessment needs and management objectives, which in some cases do not currently exist. However, the conceptual model for EBFM and EBM is clear enough for the development of observing systems to continue. As objectives are more clearly defined, the observing system can be adjusted to better meet objectives. It is important to recognize that management objectives, assessment methods, and observing systems will change through time, much as the fisheries observing systems and assessment processes changed through the latter decades of the 20th century. It is a fundamental scientific challenge to combine the demand for rigid standardized observation system as those required in present survey assessments with the need for adjustments and changes to meet EBFM and EBM.

Box 2. Definitions

Ocean observations are defined as any measurement made of the ocean including geological, chemical, physical, and biological parameters. Measurements can actual or derived and made be *in situ*, remotely, or modeled.

Observing systems are collections of observing activities designed to support specific objectives.

We distinguish **operational observing systems** from research into observing technologies. Both are needed by ICES, but operational observing systems are required for the development of advice and must be maintained for years to decades.

Components of an Ocean Observing Strategy

Seven components are envisioned for the ICES observing strategy and all seven apply to ocean observing systems in support of single species and ecosystem-based management (Box 3).

1. Data collection involves the *in situ* or remote observation of certain properties or estimation of parameters from models. *In situ* measurements will remain a critical part of ICES activities since biological information is required from resource species to support assessments. The ship-based observations of ICES and living marine resource surveys in general provide an important element to ocean observing systems, but one that is not well integrated with other observing activities (e.g. gliders, moorings, satellites, ocean models). In addition, the *in situ* observing of physical, chemical, phytoplankton and zooplankton by ICES and numerous partners is critical to meeting ICES data needs in defining ecosystem conditions and quantifying productivity. Remote data collection is very important to oceanographic observing systems (e.g.

Box 3. ICES Ocean Observing activities have seven components that need to be addressed for maintaining, improving, and developing single species and ecosystem-based management advice.

	Single-species	Ecosystem-based
Data Collection		
Data Management		
Coordination		
Integration & Analysis		
Assessments		
Communication		
New Technologies		

satellite), and to fisheries observing systems (e.g. acoustic). Acoustic data are a standard part of many fishery assessments and there are examples of the use of remotely sensed oceanographic data in fisheries and ecosystem assessments. Moving forward, the ability to use remotely sensed data within the ICES community will need to increase. Models also are just as important as *in situ* and remote measurements to observing systems. In some cases, the blending of modelled and measured data can provide very useful 'estimates' of a parameter (e.g. atmospheric reanalysis). Models can also be used to evaluate the design of data collection (e.g. Observing System Simulation Experiments) and can be used to forecast climate and ecosystem state to serve as the basis for forecasts in support of ecological decisions. Although including modelled data in an 'observing' strategy is controversial, it is imperative that this difference be overcome and that the full suite of available information be considered for inclusion in a strategy designed to support the future data needs of ICES.

An important issue is determining which core variables to collect as part of an ICES Ocean Observing Strategy. These variables must connect to an understanding of ecosystem function, the methods used in assessments, and to the objectives of management; the latter need to be clearly defined by policy or legislation. In instances where these three criteria are not clearly defined, ICES can still move forward with designing an observing strategy based on the conceptual models presented in Box 2 with the understanding that the system will need to change and adapt as scientific understanding, assessment methods and management objectives become better defined and change through time.

2. Data management is a critical component ocean observing systems in support of ecosystem-based management. The ICES Data Center continues to provide an excellent resource to ICES expert groups. However, the field of interoperability, semantics, distributed data, and web services is growing quickly and ICES would benefit by entraining additional expertise from these communities. Further, the development of improved spatial services will be required. There also are a number of data management initiatives and ICES must interact and collaborate with these efforts (EUROGOOS, MyOcean, ECOMF, SeadataNET, IOOS, BCO-DMO) to achieve its ocean observing needs. The volume of data and the sources of data will increase dramatically, creating a challenge for ICES. Data will be collected with variable time-space scaling that needs to harmonize to be used in the variety of current and future ICES products. Tools and training to store, organize and access these larger volumes of data will be needed. As regions develop Integrated Ecosystem Assessments, they

should be encouraged to work closely with the regional community of data managers that have already developed around ocean research, ocean observing, and fisheries.

3. For more than 100 years ICES has encouraged and coordinated science in support of resource management in the North Atlantic. Continued coordination within and outside ICES is necessary to maintain current observing systems. However, coordination will even be more important in the development of new observing systems. National laboratories and research centers provide most of the data currently collected within the ICES context. These laboratories and centers are typical associated with fisheries and protected species management and ships are a dominant platform supporting data collection. There are also a number of GOOS observing efforts (e.g. EuroGOOS, US IOOS) that plan to support fisheries and ecosystem-based management. Coordination of the national and international efforts will involve a broader range of platforms (e.g., ships, satellites, moorings, ocean models). The point here is that ICES does not need to conduct all the observing activities necessary to support ecosystem-based management. Rather ICES needs to coordinate with others to obtain the data necessary to support ICES science and assessment within the context of single species and ecosystem-based management.

4. Rarely is raw data used in science or assessment products. Generally some form of integration and analysis is needed. The integration and analysis processes in the ocean observing systems in support of marine management need to be developed and documented. This will largely be done through member nations or EU funding, but ICES can serve an important coordination role. In addition, the integration and analytical products should be stored just as the raw data are stored and procedures should be implemented for making the data collection, management, integration and analysis procedures transparent to scientists and stakeholders alike. Again ICES has a role in defining procedures through consensus and best available science. These criteria are already well established within ICES and need to be extended to the development of EBFM and EBM: i) objectivity and integrity; ii) openness and transparency; iii) quality assurance and peer review; iv) integrated advice – based on an ecosystem approach; v) efficiency and flexibility; and vi) national consensus.

5. Single species assessments continue to improve and assessments under EBFM and EBM are developing (e.g. Integrated Ecosystem Assessments). Most of the assessments are implemented regionally, although the conceptual models apply generally. Regional fisheries advice should be developed in an ecosystem context and ecosystem advice should be space-based but recognize the interconnectedness of marine regions. This will require that the observing systems operate at a variety of scales and develop iteratively with the assessments. In most cases the needs of assessments will drive observing systems, but in some cases the ability of observing systems will make new assessment approaches possible (e.g. ability to monitor fish age made age-structured assessments possible). An important aspect of the observing system-to-assessment framework is the identification of indicators and reference points used in assessments and the development of observing systems to collect, manage, integrate, and analyse the data necessary to support these indicators and reference points.

6. A communication effort regarding ICES activities is critical, especially as new scientific, observing, and assessment efforts are started. As ICES improves and develops it's ocean observing systems, this needs to be communicated to scientists inside and outside ICES, managers, governments, and stakeholders. Further, communication with partners and collaborating organizations is critical. A specific approach to each audience is required.

7. New technologies are critical to and a main driver of the development of ocean observing systems in support of ecosystem based management probably more than they were critical in the development of ocean observing in support of single-species fisheries management. ICES should continue involvement in the development and the application of new technologies to critical science questions and to improving assessments. Promising technologies include multifrequency acoustics, optical approaches, genetic techniques and improvements in modelling. Focus should be placed on these technologies while at the same time remaining open to other technologies that may contribute to ICES science or advice.

These seven components need to be considered for single species, EBFM and EBM. For single-species approaches, emphasis on maintaining and improving current systems is required. For ecosystem-based approaches, emphasis on improving and developing systems is required. Importantly, objectives of management need to be clearly defined and the cost–benefit of collecting specific data needs to be assessed relative these management objectives. This will result in hard choices regarding what observing activities to continue and what new observing activities to initiate. No one institution is involved in making these choices, so ICES must work with partners to design an ocean observing system, which will be a mix of current and new activities. The ICES foundations of advice: science based, peer-review, transparency and standardization, need to be carried through all of these decisions and ultimately to ecosystem-based management advice.

These seven components also need to be reviewed and improved regularly, much like the iterative approach of stock assessments and proposed for Integrated Ecosystem Assessments. The observing systems will continually evolve as needs change and objectives clarify. A formal review, however, will allow significant changes in observing systems if needed. Further, the developed observing system must be sustained over the long term to provide consistent information for management advice. However, there may be new technologies that need to be added or historical dataseries that are no longer needed. These decisions are best made strategically with purpose rather than by chance or by institutional momentum.

An ICES Ocean Observing Strategy will provide actions to address these seven elements for both single-species and ecosystem-based assessments. Short (1-3 yrs), medium (3–5 yrs), and long term (5–10 yrs) actions will be proposed; the short-term actions will be finite and doable, while the medium and long-term actions will be more involved and may require changes in ICES activities and procedures. The development of an ocean observing strategy is complex and involves supporting current needs while moving towards future activities. The situation is complicated by the fact that future needs are not as clearly define as current requirements. However, ICES should still move forward because the conceptual model for fish population dynamics has changed. To provide the best advice, ICES needs to develop observing systems to support EBFM and EBM. Although a daunting task, it is important to realize that the current single-species stock assessments are already supported by a complex observing system that has grown and evolved over time. Similarly, ICES must commit to the development and implementation of ocean observing systems in support of EBFM and EBM.

Next Steps

The following provides a proposed schedule for the development of the ICES Ocean Observing Strategy. To see this strategy through, ICES will need to establish a formal structure; an expert group with ToRs consistent with the completion of this strategy.

In addition, ICES will need to establish a governance structure that can adapt and change the implementation of this strategy into the future.

WKOOI complete workshop report – September 2012

Draft Framework for Detailed Plan – December 2012

Seek input from topical experts, ICES EG's, ACOM, and SCICOM – completed by April 2013

Delivery of Detailed Ocean Observing Strategy – July 2013

Annex 6: DRAFT Listing of North Atlantic Ocean Science Activities

AMOC	Atlantic Meridional Overturning Circulation Program - http://www.atlanticmoc.org/
ARGO	Global profiling float project - http://www.argo.ucsd.edu/
AZMP	Atlantic Zone Monitoring Program - http://www.meds-sdmm.dfo-mpo.gc.ca/isdm-gdsi/azmp-pmza/index-eng.html
BASIN	Basin-scale Analysis, Synthesis and INtegration Program - http://www.na-basin.org/
BCO-DMO	Biological and Chemical Oceanography Data Management Office - http://bcodmo.org/
BSRP	Baltic Sea Region Programme - http://www.eu.baltic.net/
ChloroGIN	Chlorophyll Global Integrated Network - http://www.chlorogin.org/world/
CLIVAR	Climate Variability and Predictability - http://www.clivar.org/
COSYNA	Coastal Observing System for Northern and Arctic Seas - http://www.hzg.de/institute/coastal_research/structure/operational_systems/KOK/projects/ICON/index.html
ECOOP	European Coastal Sea Operational Observing and Forecasting System - http://www.ecoop.eu/
EMECO	A North Sea focused observatory and a NOOS project – http://www.emecogroup.org
EPOCA	European Project on Ocean Acidification - http://www.epoca-project.eu/
EURO-BASIN	European Basin-scale Analysis, Synthesis and INtegration Program http://www.euro-basin.eu/
EUROFLEETS	Towards and Alliance of European Research Fleets - http://ec.europa.eu/research/infrastructures/pdf/eurofleets.pdf
EuroGOOS	European Global Ocean Observing System - http://www.eurogoos.org/
EuroSITES	European Open Ocean Observatory Network - http://www.eurosites.info/news.php
FerryBox	European Ferrybox Community - http://www.ferrybox.org/
GEOTRACERS	An Integrated Study of the Marine Biogeochemical Cycles of Trace Elements and Their Isotopes - http://www.ldeo.columbia.edu/res/pi/geotraces/
GMES	Global Monitoring for Environment and Security - http://www.gmes.info/
GDP	Global Drifter Program - http://www.aoml.noaa.gov/phod/dac/index.php
GOOS	Global Ocean Observing System - http://www.ioc-goos.org/
GreenSeas	Development of global plankton database and model system for eco-climate early warning -

	http://cordis.europa.eu/fetch?CALLER=FP7_PROJ_EN&ACTION=D&DOC=1&CAT=PROJ&RCN=97177
IBIROOS	Ireland-Biscay-Iberia Regional Operational Oceanographic System - http://www.ibi-roos.eu/
ICES Data Center	International Council for the Exploration of the Sea Oceanographic Database and Services - http://www.ices.dk/ocean/
IMBER	Integrated Marine Biogeochemistry and Ecosystem Research - http://www.imber.info/
JERICO	Joint European Research Infrastructure network for Coastal Observatories - http://www.moon-oceanforecasting.eu/files/moonmeeting201103/new_project_jerico_a_crise.pdf
MARCOOS	Mid-Atlantic Regional Coastal Ocean Observation System - http://www.marcoos.us/
MyOcean	Ocean Monitoring and Forecasting - http://www.myocean.eu/
NCOF	National Centre for Ocean Forecasting - http://www.ncof.co.uk/
NERACOOS	Northeastern Regional Association of Coastal Ocean Observing Systems - http://www.neracoos.org/
NODC	National Oceanographic Data Center http://www.nodc.noaa.gov/
NOOS	Northwest European Shelf Operational Oceanographic System, a EuroGOOS regional observing system - http://www.noos.cc/
OCD	Atlantic Oceanographic and Meteorological Laboratory Ocean Chemistry Division - http://www.aoml.noaa.gov/ocd/ocdweb/index.html
OCE	Northeast Fisheries Science Center Oceanography Branch - http://www.nefsc.noaa.gov/epd/ocean/MainPage/
OceanScope	http://www.scor-int.org/Working_Groups/wg133.htm
OOI	Ocean Observing Initiative - http://www.oceanleadership.org/programs-and-partnerships/ocean-observing/ooi/
OTN	Ocean Tracking Network - http://oceantrackingnetwork.org/
POGO	Partnership for Observation of the Global Oceans - http://www.ocean-partners.org/
RAPID	Rapid Climate Change - http://www.noc.soton.ac.uk/rapid/
SEPRISE	European Real-time Data Service - http://www.seprise.eu/
SOOP	Ship of Opportunity Program - http://www.aoml.noaa.gov/phod/soop/index.php
WBTS	Western Boundary Time Series (WBTS) in the Atlantic Ocean - http://www.aoml.noaa.gov/phod/wbts/index.php
WSO	Western Shelf Observatory, a UK and Irish partnership. http://westernshelfobservatory.org