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2nd Interim Report of the Working Group on the Northwest Atlantic Regional Sea (WGNARS)

23–27 February 2015

Dartmouth, NS, Canada

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CIEM Conseil International pour l'Exploration de la Mer

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Executive summary

The sixth meeting of the Working Group on the Northwest Atlantic Regional Sea (WGNARS), chaired by Robin Anderson, Canada and Sarah Gaichas, USA, was held at the Northwest Atlantic Fisheries Organization (NAFO) Secretariat in Dartmouth, NS, 23–27 February 2015. The meeting was attended by 12 participants from the US and Canada, with an additional eight participants calling in to portions of the meeting. The overarching objective of WGNARS is to develop Integrated Ecosystem Assessment (IEA) capacity in the Northwest Atlantic region to support ecosystem approaches to science and management. The NW Atlantic region has well-developed ocean observation systems, marine ecosystem surveys and habitat studies, though social and economic data collection systems are less well developed, and steps are being taken throughout the region to organize existing information and effectively communicate it to stakeholders and decision-makers. These continuing synthesis efforts were reviewed at the meeting.

In this meeting, the group maintained a working format with emphasis on group discussion, interaction, analysis, and decision-making. WGNARS aims to produce parallel products: “worked examples” of linked IEA components making best use of the collective expertise in the group (primarily natural and social sciences and fisheries/ocean management), and more general scientific advice on the process for operational IEA implementation in the Northwest Atlantic. In 2014, the group identified two specific ecoregions to be compared within the Northwest Atlantic Regional Sea: the Georges Bank/Gulf of Maine ecoregion and the Grand Banks ecoregion. Sessions in 2015 were designed to achieve two main goals: (1) identifying alternative management strategies to achieve objectives outlined in 2014 and (2) identifying multiscale ecosystem responses to large-scale drivers and key human activities outlined in 2014. (Bottom water temperature, surface water temperature, sea ice cover and timing, freshwater input, stratification and salinity were identified as key large-scale biophysical drivers. Fishing and energy development and/or exploitation were identified as the major large-scale anthropogenic interactions.) This work is in preparation for an ecosystem-level management strategy evaluation (MSE) in 2016.

The group made considerable progress towards these goals, primarily by applying a "conceptual model" framework to organize and identify linkages between candidate management objectives, human activities, key components of the ecosystem and human systems, and the large-scale drivers identified in 2014. Lists of example specific, measurable, achievable, relevant, and time-bound (SMART) operational management objectives for both Canada and the US were developed prior to the meeting based on existing management plans and legislation, and were reviewed and further refined at the meeting. Another important tool developed at the meeting was an "MSE Framework" spreadsheet based on the conceptual models for each region. This spreadsheet allowed us to link specific objectives with ecosystem and human system components, human activities, and indicator time-series. Using this spreadsheet, we also made an initial evaluation of spatial and temporal scale for linkages between large-scale drivers and ecosystem/human system responses, and also began to "bundle" management tools into potential management strategies. Finally, the group identified two time periods with sufficient contrast in the largescale drivers to compare ecosystem and human system responses across the two ecoregions, and outlined the work required to be ready to complete an MSE in 2016. Work on completing the conceptual models and

MSE framework spreadsheet, and further compiling and vetting indicator time-series for the MSE analysis will continue between the 2015 and 2016 meetings.

1 Opening of the meeting

The ICES Working Group on the Northwest Atlantic Regional Sea (WGNARS) met at the Northwest Atlantic Fisheries Organization (NAFO) Secretariat in Dartmouth, NS, Canada for its 2015 meeting. Fred Kingston, in his capacity as NAFO Executive Secretary, welcomed the participants to the WGNARS meeting.

2 Adoption of the agenda

The 2015 Agenda was developed to address a subset of the three-year Terms of Reference (ToRs) for 2014–2016 developed by the WGNARS chairs in 2013. Since the group's mandate requires coordination among many groups working toward development of Integrated Ecosystem Assessments (IEAs) and an Ecosystem Approach to Management (EAM), the meeting started with brief presentations reviewing previous work by WGNARS, the NAFO Working Group on Ecosystem Approach to Fishery Management (WGEAFM), as well as updates on national and regional IEA and EAM activities in Canada and the US.

The overall workplan was first to review products completed prior to the 2015 meeting: (1) Example management objectives and indicators to evaluate system status relative to objectives; and (2) Selected large-scale drivers for full region and associated indicators. Then, based on these, to continue to identify best practices and develop "worked example" IEA products while addressing ToRs c and d: (1) Identify multiple alternate management strategies that could achieve management objectives; (2) Discuss which indicators associated with management objectives may best represent system response to changes in large-scale drivers, and at what scale; (3) Identify frameworks (ecosystem models, possibly risk assessment frameworks, etc.) to work towards IEA management strategy evaluation (to be done in 2016).

3 Introduction: Review of integrated ecosystem assessment activities in ICES, NAFO, DFO, and NOAA (ToR a)

Work is underway in a variety of contexts around the North Atlantic to develop Integrated Ecosystem Assessment (IEA) methods and approaches to support an Ecosystem Approach to Management (EAM). To help coordinate these efforts and benefit from their progress, the WGNARS meeting opened with a review the new ICES strategic plan, WGNARS own past work, and updates on IEA/EAM related work in ICES, NAFO, DFO, and NOAA.

WGNARS background and overview of 2014–2016 ToRs (Sarah Gaichas)

Sarah briefly presented the topics of and results from past WGNARS meetings and the 2014–2016 ToRs. The Levin *et al.* (2009) IEA framework (Figure 1a) has structured the work of the group since the initial meeting in 2010. Visualization of the IEA framework has evolved since then (Figure 1b), but its components remain the same. Considerable work has already been done compiling and reviewing ecosystem indicators across the themes of climate, biodiversity and habitat. Social sciences were integrated within the group early on, and the group continues to work on more fully integrated ecological and human dimensions in IEAs, as well as improved integration of natural science, social science, and management expertise within the group. Issues of spatial scale have been important since the beginning because the Northwest Atlantic Regional Sea encompasses a variety of diverse ecoregions across a wide range of latitudes, physical oceanographic regimes, and habitats, as well as multiple administrative and management jurisdictions and boundaries, sociocultural groups and regional economies.

In 2013, WGNARS transitioned to a working format with longer (5-day) meetings focused on reviewing IEA component methods and applying them to test cases in the region. The 2013 sessions on IEA scoping, ecosystem indicator thresholds and performance testing, and risk analysis led to related peer-reviewed publications and established the context for development of three-year (2014–2016) ToRs (Annex 3). The 2014–2016 ToRs build upon the previous work to address linked IEA components including assessment of ecosystem status relative to EBM goals and management strategy evaluation. The 2015 ToRs, meeting workplan, and expected deliverables were reviewed with the group in the context of the full set of ToRs (including 2014 results) and the three-year workplan. Ultimately, WGNARS plans to continue to develop parallel products: (1) "worked examples" of linked IEA components, and (2) advice on developing processes for operational IEA implementation emphasizing the need for iteration between science, policy, and management.

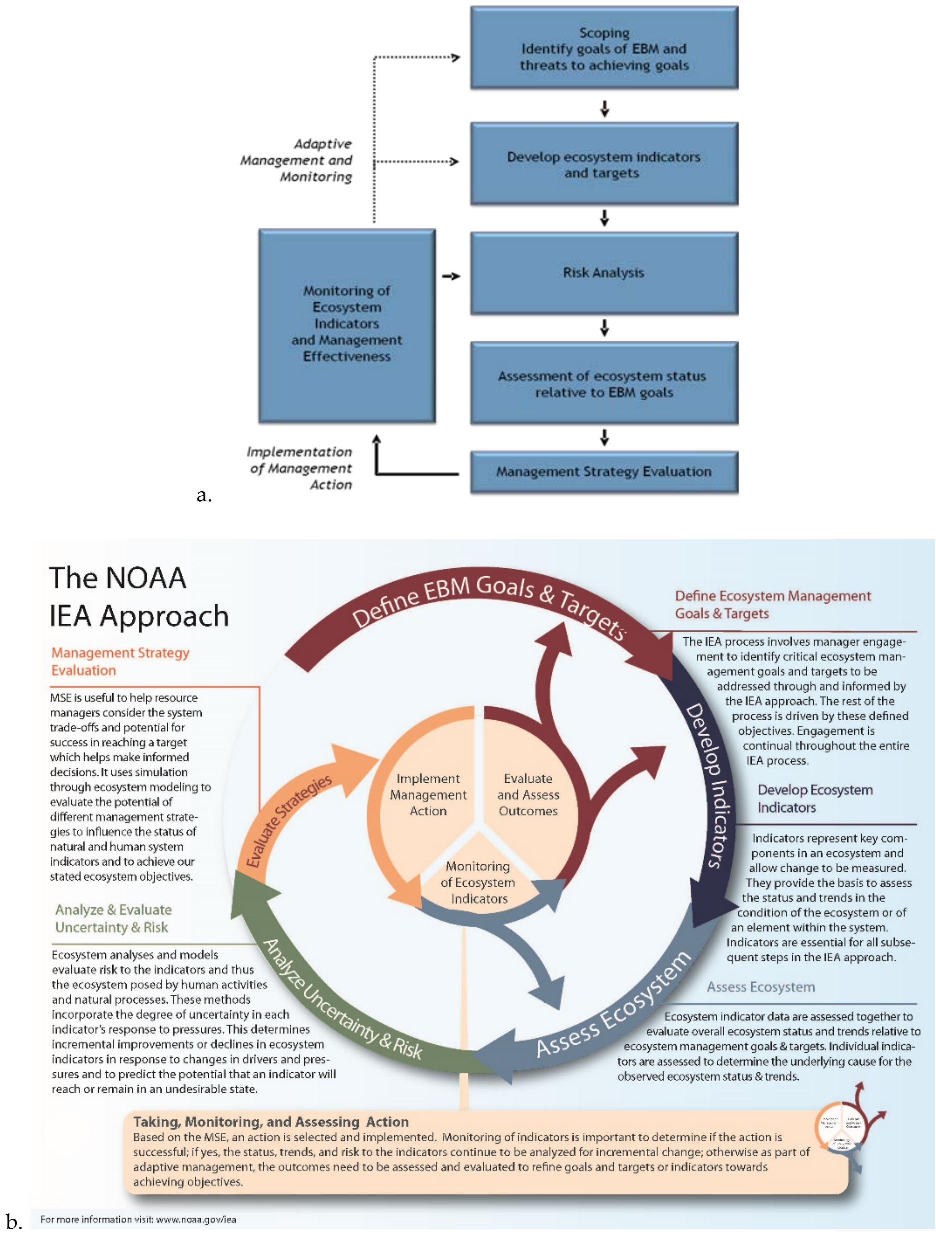

Figure 1. Visualizing IEAs. a. Levin *et al*. (2009) b. Refined IEA representation.

NOAA Integrated Ecosystem Assessment Program: 2015 Update (Rebecca Shuford)

NOAA's Integrated Ecosystem Assessment (IEA) program (www.noaa.gov/iea) continues to make progress in all five regions where it is currently being implemented (i.e. California Current, Gulf of Mexico, Northeast Shelf, Alaska Complex, and Pacific Islands).

"Conceptual models" developed for the California Current IEA were presented which proved pivotal to the work of WGNARS at this meeting. Conceptual models are intended to provide a unifying framework that crosses disciplines, and clarifies system boundaries and any gaps in knowledge. They are invaluable as a communication tool within an IEA working group, with other scientists, and with the public. This framework allows linking of indicators with elements of the conceptual models, as well as linking concepts across ecological and social components of a given system. The California Current IEA project worked for over a year to produce a set of linked conceptual models in December 2014, as illustrated in Figure 2.

In developing these conceptual models, the IEA team looked at each focal ecosystem component to develop links between ecological interactions (e.g. what are the strongest foodweb interactions), environmental drivers (what are the acknowledged drivers of abundance and community composition?), human activities (what are the strongest known human interactions or human risks posed to this focal ecosystem component?) and human wellbeing (what is the human dimensions context?).

Examples of both the working conceptual models developed by scientists and the final products developed by the graphic designer were presented. Detailed linkage models were developed for six ecosystem components: salmon species, coastal pelagic species, groundfish species, marine mammals, seabirds, biodiversity, and habitat. The California Current IEA project will be using these conceptual models to improve communications with regional fishery management councils regarding key linkages between managed species and the environment, in groundfish stock assessment ecosystem considerations sections, and on their webpages for navigation by users to see linked information on status, trend, indicators, etc.

Two references were recommended: Conceptual models as tools for communication across disciplines (Heemskerk *et al.*, 2003, Conservation Ecology), and the WA State Academy of Sciences review of EBM by Puget Sound Partnership (Orians *et al.*, 2012). Orians *et al.* (2012) concluded that the PSP process was hindered by failure to use conceptual framework to summarize key attributes of Puget Sound.

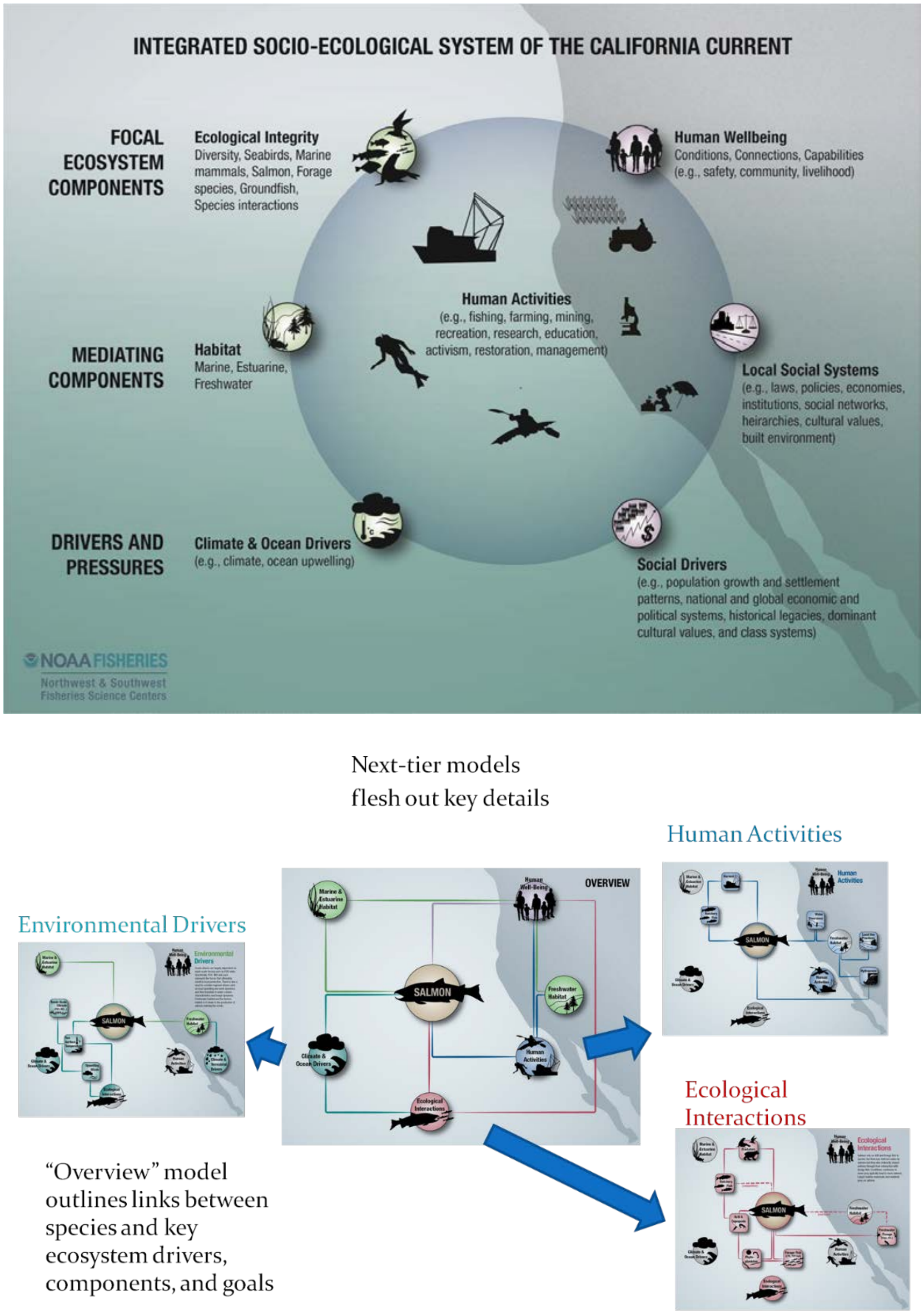

Figure 2. California Current conceptual models: overall system and detailed models linking environmental drivers, human activities, and ecological interactions for key ecosystem components. A set of models was developed for each focal component (salmon are shown here but others include coastal pelagics, marine mammals, etc.).

Northeast US IEA activities update (Mike Fogarty)

Mike demonstrated the updated Northeast US Ecosystem Status Report, an entirely web-based product. Relative to the previous release, this version features an expansion of human dimensions, stressors and impacts, status determination, and summary sections. The summary section can also be provided as a stand-alone printed annual "state of the ecosystem" report. Plans are in place to develop cumulative impact analysis and a marine ecosystem services assessment index, which would assign numerical scores for the status of delivery of a suite of ecosystem services that we have identified. Additional IEA activities include services to the two US Fishery Management Councils: providing scientific advice for the development of forage fish initiatives, a climate white paper for the Mid-Atlantic Council, and other general EAFM initiatives. Members of the program participate on Scientific and Statistical Committees and Plan Development Teams for the Fishery Management Councils. Work also continues in support of the two Regional Ocean Councils, including development of portals for indicator dissemination, spatial analysis of species distribution patterns, biodiversity hot spots, and vulnerability analysis. We also support climate initiatives (and have developed a climate webpage), including the US national climate vulnerability assessment for fish which was piloted in our region. Research continues into identifying regime shifts, and in multispecies and ecosystem modelling.

Canadian IEA activities update (contributions from Catherine Johnson, Heather Breeze, Sara Quigley, Alida Bundy, Martine Giangioppi, Nadine Templeman, Melissa Abbott and Robin Anderson)

Various DFO sectors have undertaken activities contributing to development of IEAs and Integrated Oceans Management (IOM) in the past several years, but coordination among these activities and implementation of the results have not always occurred. There may be opportunities for enhanced coordination of IOM and IEA following the departmental reorganization that is underway. At the national level, policy for Arctic EAM is under development for the Arctic Council, and the Arctic Council’s Ecosystem Approach Expert Group has plans for work to resolve data issues, to compile strategic ecosystem objectives and species and habitat management strategies, develop pilot programs in the Arctic LMEs, and coordinate of EAM in the Arctic and with other DFO regions. There is a new IM initiative under development for DFO and draft policy documents from Oceans and Fisheries Management are under review by various sectors. A number of national and international initiatives including the United Nations Environment Programme (UNEP) – The Economics of Ecosystems and Biodiversity (TEEB; 4OC) GRID-Arendal “TEEB4OC” project (The Economics of Ecosystems and Biodiversity for Oceans and Coasts) may offer opportunities to contribute to pilot studies for IEA. Projects related to national commitments under the Convention on Biological Diversity (CBD CoP12) may also be relevant to WGNARS activities.

Substantial guidance for working through various elements of the Levin *et al.* 2009 framework has been developed by the DFO Oceans and Science Branches and is documented in DFO reports and publications. In addition, EAM Working Groups have been set up in both at the national level and the Maritimes region, although their work is currently on hold during the departmental reorganization. In the DFO Maritimes region, an Ecosystem Assessment team has been formed in the Science Branch, and work is underway to mobilize support for the team. The Maritimes region Ecosystem Management branch plans to use large marine ecosystems (LMEs) as the relevant scale for implementation of integrated management (IM). Their current focus is on developing profiles of Ecologically or Biologically Sensitive Areas (EBSAs) with priority determined by level of human activity. Investigators supported by two DFO internal funding pools, the Aquatic Climate Change Adaptation Services Program (ACCASP) and the Strategic Program for Ecosystem-Based Research and Advice (SPERA) have undertaken projects relevant to IEA, including evaluation of integrated ecosystem status, trends and assessment and development of tools to identify which stocks are most vulnerable to climate change. However, the total funding to these programs is limited and must serve the entire country, and therefore most funding has gone to urgent issues rather than strategic needs. Policy and management challenges remain to address even well documented ecosystem-level issues such as the need for management tools to address multispecies fisheries interactions.

NAFO IEA activities update (Mariano Koen-Alonso, chair NAFO WGESA)

As reported last year, the Northwest Atlantic Fisheries Organization (NAFO) is committed to apply an ecosystem approach to fisheries management in the Northwest Atlantic that includes safeguarding the marine environment, conserving its marine biodiversity, minimizing the risk of long term or irreversible adverse effects of fishing activities, and taking account of the relationship between all components of the ecosystem. The process and guiding principles that NAFO is following to achieve this goal is summarized in the organization's "Roadmap for developing an Ecosystem Approach to Fisheries for NAFO" (hereafter referred as "Roadmap"). The current representation of the Roadmap (Figure 3) provides an operational perspective of how the Ecosystem Approach to Fisheries (EAF) is being conceived in a work-flow process that suits NAFO structure and practices. This schematic incorporates the hierarchical approach to define exploitation rates, and integrates the impacts on benthic communities (e.g. Vulnerable Marine Ecosystems –VMEs-) associated with the different fisheries that take place within the ecosystem.

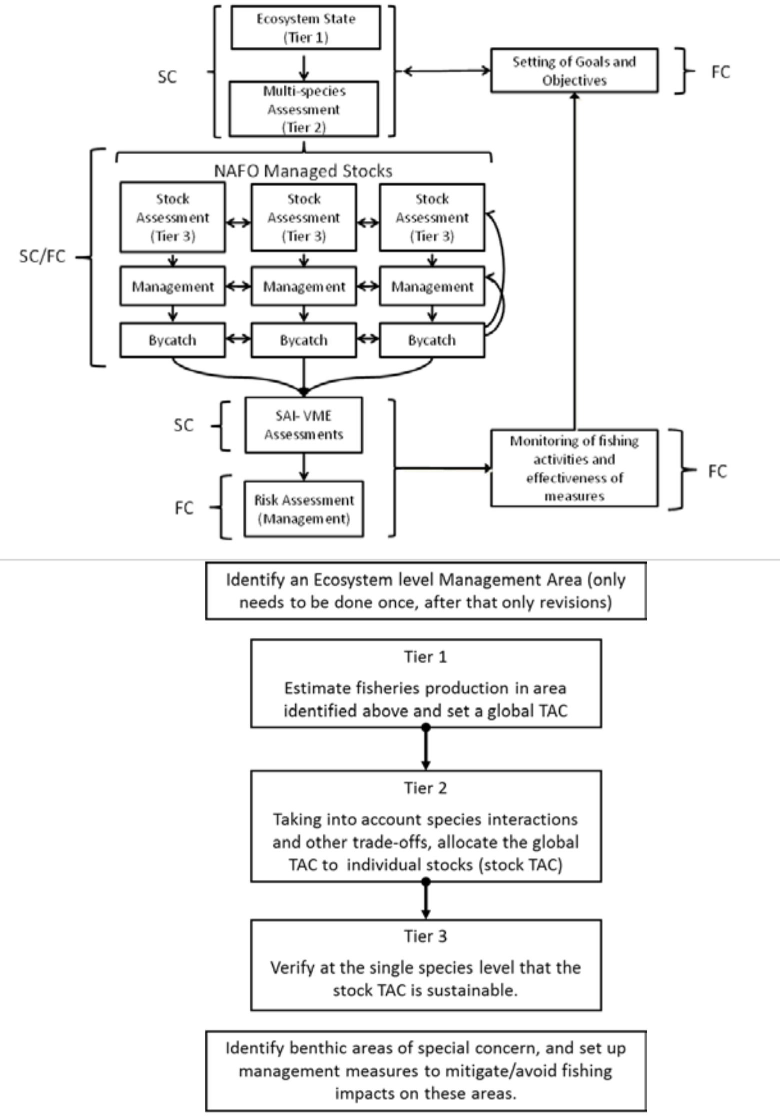

Figure 3. Current working template of the NAFO "Roadmap" (left), with a synoptic overview of the key steps required for using it (right). SC: Scientific Council, FC: Fisheries Commission, SAI: Significant Adverse Impact, VME: Vulnerable Marine Ecosystem.

In the context of the Roadmap (Figure 3), NAFO Scientific Council (SC) explicitly identified the need for developing more specific/functional connections and collaborations with ICES WGNARS on, but not limited to:

- Ecosystem State (Tier 1)
  - defining spatial management units
  - exploring temporal variability of units
  - defining productivity state and its variability
- Multispecies assessment (Tier 2)
  - description of species interactions and trends
  - quantification of diets and predation
  - understanding the role of environmental drivers in ecosystem structure and dynamics

- understanding the response of foodwebs to anthropogenic impacts
- definition of multispecies reference points
- provision of advice on candidate TAC based on multispecies considerations

In 2014, NAFO Working Group on Ecosystem Science and Advice (WGESA) activities under the Roadmap included further exploration of VMEs in the Grand Bank (follow up from review of closures), continuing work on assessment of bottom fishing impacts on VMEs (2016 deadline), classification of fisheries, preliminary estimation of fishing effort using Vessel Monitoring System (VMS) data, relationship between fishing effort and VMEs, identification of basic spatial domains and definition of Ecosystem Production Units (EPUs), new runs of Ecosystem Production Potential (EPP) models for the updated EPUs, and initial exploration of refined model structure, and agreement on putting forward guidelines for total catches in some of the identified EPUs. In addition, NAFO explored updated diet information for key spp, and initial results from complementary stable isotope analyses for the NL shelves ecosystem. They are also developing a summary of activities other than fishing that could impact fish production in the NAFO Regulatory Area (NRA).

As NAFO's ecosystem approach evolves under the Roadmap, the goal is to integrate ecosystem considerations into all aspects of the organization. At the present time, research and science advice components are being addressed by NAFO SC and its Working Group on Ecosystem Science and Assessment (WGESA, formerly known as Working Group on Ecosystem Approaches to Fisheries Management, WGEAFM). Those aspects related to the implementation of the science advice, including the revision and/or development of management practices, are being addressed by joint Working Groups (WGs) between NAFO Fisheries Commission (FC) and SC. These joint FC/SC WGs include the WG on Risk-Based Management Strategies (FC/SC WGRBMS), which deals with issues related to stock rebuilding plans, and the Precautionary Approach (PA), the WG on the Ecosystem Approach Framework to Fisheries Management (FC/SC WGEAFFM), which deals with issues related to VMEs, but also the overall implementation of the Roadmap from a management perspective, and a specific ad hoc FC/SC WG on Catch Reporting, which is focused on improving the quality of NAFO catch statistics, and resolving the discrepancies between difference sources of data. In addition to these WGs, FC also has created a specific WG to deal with issues of bycatch and discards from a regulatory perspective. Most of these WGs are of recent creation, and NAFO is still in the early stages of developing ways to make the full implementation of the Roadmap operational; however, key to the full process is the concept of modularity, which implies that different components of the Roadmap can be made operational as they their development matures, without waiting for the full approach to be completely developed before making it operational. This modular concept should not only allow an putting in practice components of the Roadmap earlier, it would also allow a gradual transition from current practices into EAF, while ironing out the problems that will emerge as the organization moves from concept to actual practice.

4 Working session on Management Strategies (ToR d)

Work under this ToR was structured into a review session and a working session. First, we reviewed lists of objectives from 2014 and results of operationalizing objectives. After this review, we began the task of aligning objectives with potential management measures to achieve them. We found that the conceptual model framework was extremely useful for organizing our thoughts, so we first developed conceptual models for the Canadian (Grand Banks) and US (Georges Bank/Gulf of Maine) ecoregions based on the lists of objectives, and the large-scale drivers and human activities selected in 2014.

4.1 Operational Objectives Review

Level 1 Objective (from WGNARS meeting): *Optimize the flow of benefits generated from ocean resources, for both producers and consumers, given the other objectives.*

Working Group: *Heather Breeze, Catherine Johnson, Robin Anderson, Christa Waters, Alida Bundy, Brian Leung, Melissa Abbott*

Purpose: to come up with two to four operational objectives, using the overall objective of "optimizing benefits" for the Placentia Bay-Grand Banks region. Ideally, operational objectives should cover at least two sectors.

Context: The idea of "optimizing benefits" has support in existing Newfoundland and Canadian documents, e.g. the Placentia Bay-Grand Banks Integrated Management Plan, the Atlantic Accord, etc. (see Appendix A). It is clear from these documents that there is a preference for benefits to flow to certain groups, such as coastal communities, Aboriginal people, Province of Newfoundland. As well, the idea of "benefits" is tempered by some of the other high-level socio-economic and cultural objectives:

- Promotion of economic diversity (Placentia Bay-Grand Banks Integrated Management Plan, Placentia Bay [coastal] Integrated Management Plan)
- Promotion of benefits for the country in general and Newfoundland and Labrador in particular (Atlantic Accord)
- Respecting Aboriginal and treaty rights
- [Supporting] a commercial fishery in Atlantic Canada with a strong independent inshore sector (Policy on Independence of Inshore Fleet, DFO).

From these documents, it is clear that the idea of benefits includes:

- Retention of wealth/benefits (in general) in coastal and Aboriginal communities
- Employment in coastal communities or in Newfoundland and Labrador generally
- Support/promotion of the fishing industry as an important part of economic, social and cultural well-being

In the overall objective, "producers" and "consumers" are mentioned as particular groups to whom benefits should flow. "Consumers" as a benefitting group are not mentioned in the Newfoundland documents. As well, the US working group selected food provision, recreational opportunities and stability as other important benefits. The importance of "food provision" and "stability" are implicit in many of the DFO policies and Newfoundland documents. However, it is not clear that "recreational opportunities" are as much of a priority as the other benefits. This context informed the selection of the objectives below.

Operational Objectives: The operational objectives are adapted from the documents listed in Appendix A. In some cases, wording is directly taken from those documents. Indicators were selected by the working group. This is not an exhaustive list of operational objectives, but it does provide examples from different sectors.

A. Optimize the flow of benefits generated from ocean resources, for both producers and consumers, given the other objectives.
    1. Ocean resources support employment in coastal communities and in Newfoundland.
        a. Maximize oceans-resource related employment in Placentia Bay coastal communities, given the other objectives
            i. Indicators: Number of oceans-related jobs in Placentia Bay.
        b. Ensure that the benefits of fishing licenses flow to the fish harvester and the coastal community
            i. Indicators: Number of fishing licenses held by members of coastal communities (as compared with those held by companies/communities outside the region) for fisheries in NAFO Divisions XX and XX].
            ii. Indicators: Number of fisheries spin-off jobs in coastal communities
        c. Provincial residents are given first consideration for training and employment opportunities in the offshore oil and gas industry.
            i. Indicators: Number of provincial employees in offshore oil and gas industry training programs; number of provincial residents employed by the offshore oil and gas industry.

    2. Economic opportunities are optimized within the bounds of resource sustainability.
        a. Maximize revenues from ocean resources, given the other objectives.
            i. Indicators: Sum of revenues from commercial fisheries, revenues from recreational fisheries; revenues from oil and gas sector, revenues from marine tourism, revenues from marine renewable energy, etc.

    3. Treaty rights related to ocean resources are respected and Aboriginal people have access to ocean resources.
        a. Aboriginal people are provided access to fisheries for food, social and ceremonial purposes.
            i. Indicators: Number of FSC (food, social, ceremonial) licenses in region; number of FSC licenses/Aboriginal community.
        b. Each Aboriginal community has XX commercial fishing licenses.
            i. Indicators: Number of commercial fishing licenses/Aboriginal community

c. Aboriginal Newfoundlanders have opportunities to work in the offshore oil and gas industry.
    i. Indicators: Number of Aboriginal Newfoundlanders employed in the offshore oil and gas industry; number of Aboriginal companies/cooperatives supplying goods and services to the offshore oil and gas industry.

4. Wealth and benefits generated by ocean resources are retained in nearby communities (scale of community may vary depending on the resource: coastal, Aboriginal, provincial). *This objective could be seen to overlap with number 1; the focus here is on non-employment related benefits.*
    a. Assist fish harvesters to retain control of their fishing enterprises.
        i. Indicators: Number of fishing licenses held by owner/operators as compared with those held by companies.

Appendix A: Compilation of Relevant Objectives from Newfoundland Initiatives

Note that these were not always called "objectives" in the original documents; they may have been called goals, strategies, actions, etc. The Working Group sorted them into level 1, level 2, etc. as an exercise to help in the development of operational objectives.

Level 1 (from WGNARS meeting): Optimize the flow of benefits generated from ocean resources, for both producers and consumers, given the other objectives.

Level 1 (Placentia Bay-Grand Banks Integrated Management Plan): Goal: Sustainable Use. The intent of the sustainable use goal is for current and future generations to derive social, economic and cultural benefits from the safe use of coastal and ocean areas and resources. This goal is comprised of interconnected social well-being, economic well-being, cultural well-being, and public health and safety elements.

Level 2 (Placentia-Bay Grand Banks Integrated Management Plan). Element: Economic Well-being. A diversity of economic opportunities are derived from renewable and non-renewable coastal and ocean resources.

Strategies:

- Support initiatives to optimize or improve provincial economic competitiveness.
- Assess current and potential economic opportunities, issues and activities.
- Support existing activities and opportunities, and future economic diversification and employment.
- Support a positive investment environment for coastal and ocean-related activities.
- Identify and implement measures to improve retention of wealth and benefits within coastal and Aboriginal communities.
- Support innovation and research that may contribute to economic well-being.

Level 2 (Placentia-Bay Grand Banks Integrated Management Plan). Element: Economic Well-being. A diversity of economic opportunities are derived from coastal and ocean infrastructure and coastal and ocean-related activities. (same strategies as above)

Level 2 (Placentia-Bay Grand Banks Integrated Management Plan). Element: Economic Well-being. Employment dynamics are sustainable (labour force, incomes).

Level 2 (Placentia-Bay Grand Banks Integrated Management Plan). Element: Economic Well-being. Optimize economic opportunities within the bounds of resource sustainability.

Strategies:

- Balance industrial capacity with resource sustainability.
- Support the conservation of natural capital by recognizing, linking to and working with related ecosystem objectives and strategies.
- Examine cost and benefits for the best use of resources.
- Identify and link to existing policies, plans and initiatives for sustainable economic development.

Level 2 (Maritimes IFMP template): Culture and Sustenance: Respect Aboriginal and treaty rights to fish.

Level 3: Provide access for food, social and ceremonial purposes

Level 2 (Newfoundland Coastal Strategy): Sustainable economic opportunities pertaining to coastal, ocean areas, and resource use are supported.

Level 3 (Newfoundland Coastal Strategy): Efforts to support and strengthen the fishing industry across the province through various programs and initiatives will continue as the fishery remains an important part of the province's economic and social well-being.

Level 2 (Placentia Bay IM Plan [coastal]): Promote the diversification of the economy to encourage economic stability.

Level 3 (Placentia Bay IM Plan): Encourage local communities to use their strengths in a focused and collaborative approach.

Level 3 (Placentia Bay IM Plan): Encourage local industries to increase opportunities for local communities.

Level 3 (Placentia Bay IM Plan): Advocate incentives for industry development.

Level 2 (Policy for Independence of Inshore Fleet): [Support] a commercial fishery in Atlantic Canada with a strong independent inshore sector.

Level 3 (Policy for Independence of Inshore Fleet): reaffirm the importance of maintaining an independent and economically viable inshore fleet;

Level 3 (Policy for Independence of Inshore Fleet): strengthen the application of the Owner-Operator and Fleet Separation policies;

Level 3 (Policy for Independence of Inshore Fleet): ensure that the benefits of fishing licences flow to the fish harvester and the coastal community; and

Level 3 (Policy for Independence of Inshore Fleet): assist fish harvesters to retain control of their fishing enterprises.

Level 1 (Atlantic Accord): [P]rovide for the development of oil and gas resources offshore Newfoundland for the benefit of Canada as a whole and Newfoundland and Labrador in particular. […] It is the objective of both governments to ensure that the offshore area is managed in a manner which will promote economic growth and development in order to optimize benefits accruing to Newfoundland in particular and to Canada as a whole.

Level 2 (Atlantic Accord): [B]efore the start of any work program for exploration or field development, a plan must be submitted satisfactory to the Board for the employment of Canadians and, in particular, members of the provincial labour force and for providing manufacturers, consultants, contractors and service companies in Newfoundland and other parts of Canada with a full and fair opportunity to participate in the supply of goods and services used in that work or activity.

Level 3 (Husky Energy) Husky encourages the participation of designated groups (women, Aboriginal peoples, persons with disabilities and members of visible minorities), and corporations or cooperatives owned by them, to supply goods and services.

Level 2 (Atlantic Accord): In its review of Canada and Newfoundland benefits plans, the Board shall seek to ensure that first consideration is given to services provided from within Newfoundland, and to goods manufactured in Newfoundland, where such goods and services are competitive in terms of fair market price, quality, and delivery.

Level 2 (Atlantic Accord): The Board shall also require that any such plans include particular provisions, consistent with the Canadian Charter of Rights and Freedoms, to ensure that individuals resident in Newfoundland are given first consideration for training and employment opportunities in the work program for which the plan was submitted.

Level 3 (Husky Energy): Provincial residents are given first consideration for training and employment opportunities.

Level 2 (Atlantic Accord): Regional Security of Supply. Hydrocarbons produced from the offshore area will be made available to Newfoundland and Labrador on commercial terms to meet both total end use consumption and the feedstock requirements of industrial facilities in place on the day that legislation implementing this Accord is proclaimed.

Level 3 (Husky Energy Husky encourages the participation of designated groups (women, Aboriginal peoples, persons with disabilities and members of visible minorities), and corporations or cooperatives owned by them, to supply goods and services.

Source Documents

The Atlantic Accord. Memorandum of Agreement between the Government of Canada and the Government of Newfoundland and Labrador on offshore oil and gas resource management and revenue sharing. February 1985. http://www.servicenl.gov.nl.ca/printer/publications/aa_mou.pdf

DFO Maritimes Region IFMP Template. (unpublished)

DFO. Policy for Preserving the Independence of the Inshore Fleet in Canada's Atlantic Fisheries. http://www.dfo-mpo.gc.ca/fm-gp/initiatives/piifcaf-pifpcca/piifcaf-policy-politique-pifpcca-eng.htm

Husky Energy. Canada-Newfoundland & Labrador Benefits. http://www.huskyenergy.com/operations/growthpillars/atlantic/benefits.asp

Placentia Bay/Grand Banks Large Ocean Management Area Integrated Management Plan (2012–2017). February 2012. http://www.icomnl.ca/files/PBGB%20LOMA%20IM%20Plan.PDF

Placentia Bay Integrated Management Plan.2007. http://www.icomnl.ca/files/PBIMC%20Integrated%20Management%20Plan.PDF

WGNARS High Level Conservation Objectives:

A. Biomass and productivity of harvested and other species are healthy.

B. Trophic structure is healthy.

WG: Sean Lucey, John Manderson, Nancy Shackell, Pierre Pepin, *Catherine Johnson, Mariano Koen-Alonzo, Alida Bundy, Mike Lowe, Sarah Gaichas, Christa Waters (Canadian)

Goal: to translate (unpack) high-level ocean management conservation objectives into SMART operational objectives with guidance from the PBGB LOMA IM Plan, and other DFO based exercises for the Canadian region, Placentia Bay/Grand Banks (PBGB)

The PBGB LOMA IM Plan is the main source of information for the initial steps of this exercise since DFO has already spent a large amount of effort in defining conservation objectives for PBGB (DFO 2012). The PBGB LOMA IM Plan has a "Healthy Ecosystems" Goal, comprised of three elements: Biodiversity, Productivity and Marine Environmental Quality. We have used the Biodiversity and Productivity elements to begin to develop and unpack the objectives for the two WGNARS high-level conservation objectives.

The PBGB LOMA IM Plan "Healthy Ecosystems - Productivity" Goal includes three strategic objectives:

1. **Primary productivity and secondary productivity are healthy.**
2. **Trophic structure is healthy**
3. **Biomass and productivity of harvested and other species are healthy.**

Since humans have little or no control over the first strategic objective, we have tried to incorporate variability of primary and secondary productivity as dynamic limits in the other two strategic objectives.

The PBGB LOMA IM Plan "Healthy Ecosystems – Biodiversity" Goal includes four strategic objectives:

1. **Diversity of benthic, demersal and pelagic community types is conserved.**
2. **Incidental mortality of all species is within acceptable levels.**
3. **At risk species protected and/or recovered.**
4. **Harmful species introductions are prevented and distribution is reduced.**

The PBGB LOMA IM Plan does not downscale these strategic objectives further, but instead identifies "Management Strategies" associated with each one. Under the Tear *et al.* (2005) criteria for objectives, the PBGB strategic objectives are not objectives, because they are not measurable; instead they would be characterized as goals. Therefore, we have used what information we can from these strategic objectives and incorporated other information sources as appropriate.

NB: the terminology of objectives should be standardized as much as possible among DFO, NOAA, and ICES.

A. Biomass and productivity of harvested and other species are healthy.

1. Maintain fishing mortality within target reference points [From EAM Maritimes framework]
    a. Keep individual species fishing mortality moderate (using PA framework where available)
        i. F (or proxy) for each harvested species
    b. Limit disturbing activity in important reproductive areas/seasons to less than XXXX
        i. Area of disturbance in areas 'a"
        ii. Area of disturbance in area "b", etc.
    c. Limit incidental mortality of non-target species within acceptable levels; fishing mortality is less than natural mortality (F<M) as a rule of thumb

        For species with no M, use reference points established for primary and secondary species – i.e. use PA framework established in DFO 2012, and DFO 2014.

        For species with no established reference points, follow procedure outlines in DFO 2014.
        (M is an information gap: as a first approximation, monitor biomass trends of non-harvested species over time – max biomass is a proxy for unfished biomass; upper and lower reference points set using accepted default assumptions)
2. At-risk or depleted species protected and/or recovered
    a. increase and secure the long-term sustainability of Atlantic cod
        i. Rebuild cod stock biomass to XXXX
    b. increase and secure the long-term sustainability of capelin
    c. increase and secure the long-term sustainability of Groundfish biomass
    d. increase and secure the long-term sustainability of Large gorgonian corals
3. Maintain total harvested species biomass above a dynamic biomass threshold
    a. Keep system level fishing mortality moderate
        i. System level F (or proxy; e.g.., total catch/total biomass - * Ecosystem exploitation (fisheries)
    b. Limit total system removals below total system cap
        i. Total catch (landings and discards) - (system cap to be derived from modelling work)
    c. Maintain harvested fisheries biomass above ecosystem level LRP
        i. Total biomass of harvested species (LRP to be derived from modelling work)

Management strategies in PBGB LOMA IM Plan

- Continue to implement (and develop) management actions to protect significant aggregations associated with spawning and juveniles.
- Implement the Precautionary Approach Framework for Total Allowable Catch (TAC) setting and keep fishing mortality of all species within acceptable levels.
- Support implementation of recovery plans for depleted species.

B. Trophic (ecosystem) structure is healthy

2. Maintain ecosystem structure within historical variation, recognizing inherent dynamic properties of the system; Ecosystem structure includes size structure, trophic structure, and functional group structure.
   a. Maintain size structure within acceptable limits
      i. *The large fish indicator
   b. Maintain trophic structure within acceptable limits
      i. *Mean trophic level of the catch
      ii. *Marine trophic index of the community (MTI)
      iii. *Mean trophic level of the community
      iv. *Mean trophic level of the modelled community
   c. Maintain functional group/guild structure within acceptable limits
      i. *Functional Group/Guild-level biomass across ecosystem components

Information gap:

What are historical ranges and how do they vary with environment?

Define acceptable limits

FGs to be defined based on CWP's work for OCMD

** based on ICES WKFOOI advice on indicators of ecosystem structure and functioning

Management strategies in PBGB LOMA IM Plan

- Define healthy trophic structure and develop indicators. [maps to ICES WKFOOI advice]
- Strengthen monitoring of predator species ecology, particularly seals. [Fill information gap]
- Promote research related to multispecies interactions (including the role of predators) in maintaining ecosystem productivity. [Fill information gap]
- Improve efforts to protect forage species

References

DFO (2012). Placentia Bay/Grand Banks Large Ocean Management Area Integrated Management Plan (2012–2017).

Tear, T. H., and 12 others (2005). How much is enough? The recurrent problem of setting measurable objectives in conservation. Bioscience, 55(10): 835–849.

Habitat integrity is conserved

The following points were considered to address this strategic objective:

- Structure
  - Ecologically significant species (ESS) e.g. eelgrass, corals, sponges…
  - Essential fish habitat (US definition)
  - Essential fish habitat (unique, **loss is permanent**) e.g. glacial relict gravel bank
  - Intersection of structure with environmental parameters

- Function
  - Cover
  - Enhanced food supply
  - Complexity
  - Diversity and abundance
- Structure and function are the aspects of habitat integrity that need to be protected
- Fish do not occupy the entire seascape
- Some habitat loss can be permanent or very long term (> 20 years, FAO guidelines??)
- So the answer to how much can we lose without an impact? is 0
- Therefore the habitat variable is the most important one to preserve
- **There is no MSY for habitat**
- The relationship between fish abundance and habitat is not linear. Are there limit reference points beyond which there is no recovery? *What are these limits?** i.e. critical habitat*
- In the Canadian fisheries protection context (Canada Fisheries Act) the question is *how much habitat does it take to produce a fish?*

Objectives:

In the context of an already damaged ecosystem

- Maintain habitat productivity
- Maintain habitat diversity
- Habitat structure and function are maintained for exploited (CRA* in Canada, "Fished" species in the US) fisheries
- Minimize the risk of permanent (<20 years) impacts
  - VMEs
  - Corals and sponges
  - Other vulnerable biogenic habitats
  - Coastal habitats vulnerable to Aquatic Invasive Species (AIS)
  - Vulnerable physical habitats (e.g. relict glacial gravel banks)

Pressures

- Physical damage = disturbance or destruction
- Pollution e.g. contaminants, eutrophication, litter (microbeads to ghost nets), sound

- Biological damage (AIS)

Management strategies to protect habitat from physical damage

- Closures (permanent or seasonal)
- Equipment restrictions (e.g. gear, cables, pipes, dredges, anchors…)

Management strategies to protect habitat from pollution

- Waste disposal guidelines and regulations
- Ballast water exchange restrictions
- Restrictions on land-based sources and industry specific sources

Indicators of habitat integrity

- Distribution and B of ESS
- How much habitat do we have and is it changing? E.g., is eelgrass distribution changing?
- Amount and % of available habitat used - Population metrics for users (N, density, B,)
- Area lost to physical damage
- Contaminants in organisms - Mussel watch
- Litter in trawls
- Microbeads in phytoplankton counts

Indicators of management measures?

*CRA Commercial, recreational and aboriginal fisheries

4.2 Conceptual Models

Based on the California Current IEA conceptual models presented earlier in the meeting, WGNARS developed conceptual models for the Canadian and US ecoregions to reflect the slightly different management objectives identified in each, which also suggested different focal ecosystem components. Draft models are presented in Figures 4 and 5.

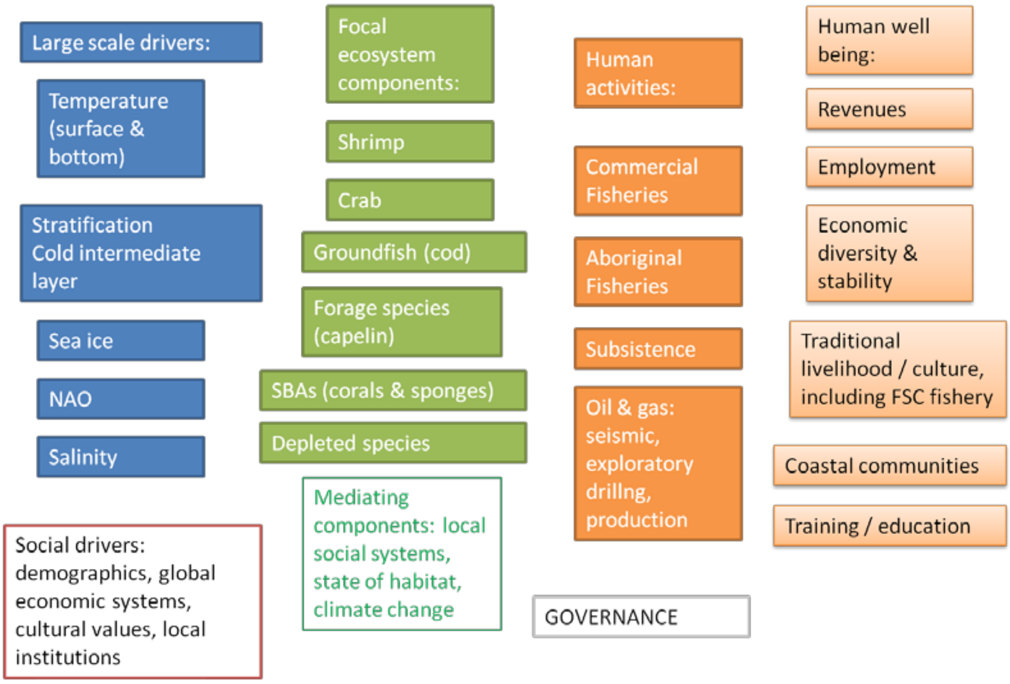

Figure 4. Canadian general conceptual model developed at WGNARS 2015.

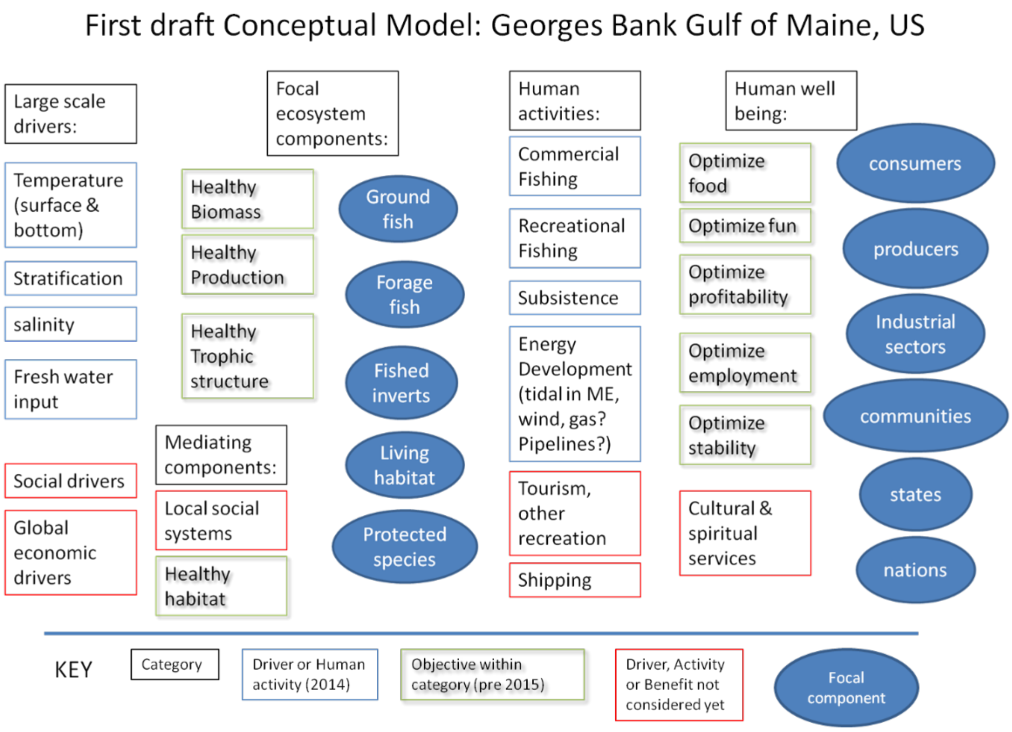

Figure 5. US general conceptual model developed at WGNARS 2015. N.B. Key indicates categories, drivers and human activities selected in 2014, drivers or activities not considered yet but are important gaps, and focal components of both ecological and human systems.

Developing these conceptual models further aided working groups from the US and Canada to fill out an MSE Framework spreadsheet developed by Mariano Koen-Alonzo (Figure 6, and see section below). This spreadsheet links operational objectives with ecological components, human activities, and potential management measures. The group also found the MSE Framework spreadsheet to be extremely useful for listing ecosystem indicator time-series, which led naturally into ToR c. It is designed to be used in a qualitative MSE analysis where trade-offs between objectives can be identified. In the course of developing the spreadsheet, we standardized our terminology as follows:

High Level Goal (mission statement, vision, mostly what we started with)

Strategic objective (long term organizational goal, specific plan/project to achieve)

Operational objective (benchmarks, workable tasks to achieve strategic objective. SMART)

Indicator (Can be related to stressors or responses, but should relate to objectives)

Performance measure (how do you know whether and how well you meet the operational objective)

Management strategies (a combined bundle of management tactics across multiple activities to achieve (and be measured against) multiple operational objectives) These are assembled under the strategy development tab in the spreadsheet, which will be done prior to the 2016 meeting.

Table 1. MSE Framework spreadsheet final column headings.

High level goal
Strategic objective
Operational objective
Focal component (Ecological, biological, habitat, human)
Human activity (e.g. fishing, energy exploration, tourism, shipping)
Approach (general tools to achieve same operational objective; may not be necessary)
Management tactic (measures, regulations applied to achieve operational objective; e.g. quota, effort limitation, best practice)
Indicator class (not specific time-series)
Indicator (specific time-series including how indicator derived; e.g. model, survey)
Indicator data source
Year range of indicator (but ideally apply ICES indicator evaluation criteria)
Spatial scale of indicator (but ideally apply ICES indicator evaluation criteria)
Performance measure (Threshold, reference point, reference direction, and or hard constraint? Will not apply in all cases)
Legal basis/authority or agency/reference
Additional comments/details

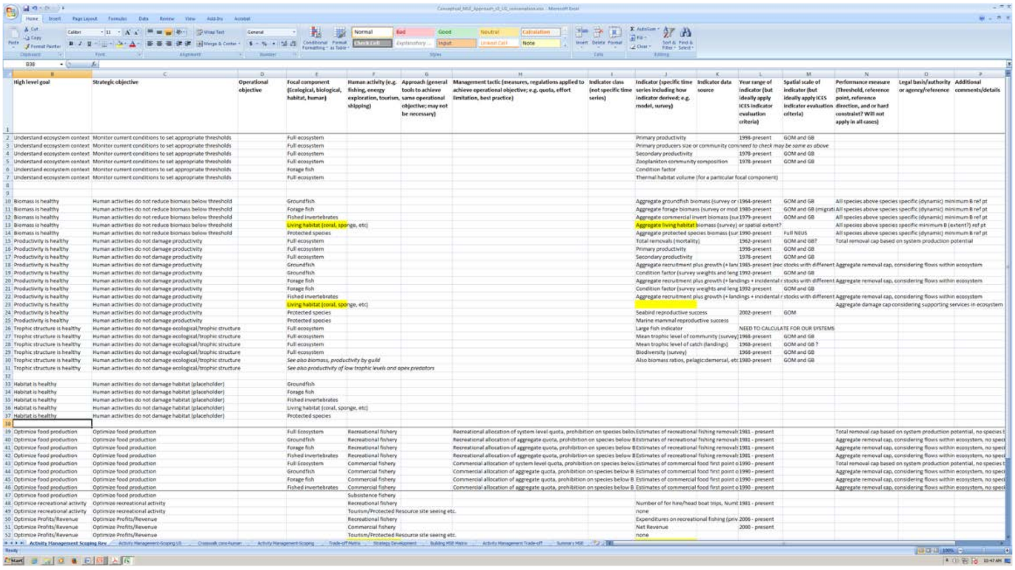

Figure 6. MSE Framework spreadsheet linking objectives, components, activities, indicators, and management strategies, as based on conceptual models (shown to illustrate layout; not intended to be legible).

5 Working session on Multiscale Ecosystem Responses and Indicators (ToR c)

Work under this ToR was structured using "second tier" conceptual models following the example of the California Current IEA. We also continued to develop our framework for IEA level MSE analysis which will incorporate all of the components developed under each ToR.

5.1 Second Tier Conceptual Models

The group worked through an exercise developing a second tier model linking the large-scale environmental drivers identified in 2014 with a focal ecosystem component common to the Canadian and US ecoregions: forage fish. On the Grand Banks, this would be primarily capelin and sandlance, while in the Gulf of Maine/Georges Bank this would be Atlantic herring and sandlance. While forage fish were treated as a group. Processes at multiple scales were included by addressing key life stages of the individual species. It was noted that all of the fish are plankton feeders, and that the variation in foodweb interactions between the species would be addressed in the ecological interactions second tier conceptual model, rather than in this one focused on environmental drivers.

In building the conceptual model (Figure 7) the group asked; Which large-scale drivers are most likely to affect forage fish (these major ones) in each system?

First looking at the adult stage, growth/maintenance processes were discussed. Adult feeding habitat overlaps considerably. For herring: sea surface temperature, stratification, and freshwater run-off were identified. The impact of salinity was less clear. For capelin: bottom temperature, sea surface temperature, sea ice, and stratification, were identified (with a dashed line added for freshwater run-off because it is not an important driver on the Grand Banks, but is important to capelin). For sandlance, which live in depths less than 90 m on sand or light gravel bottom, and burrow: bottom temperature, sea surface temperature, stratification, and freshwater run-off were identified.

When considering spawning habitat, smaller scales were important for herring and capelin. Herring are seasonally migratory. Spawning habitat is coastal kelp. Aquatic invasive species can alter this (urchins eating kelp), locally important, possibly driven by bottom temperature and disease (in Canada). Capelin have special spawning habitat on the shelf. There is a linkage between freshwater run-off and capelin production at different (smaller) scale (beach) than say sea ice which sets up ecosystem timing of productivity—food for capelin. Management difference: can protect beaches. (We cannot really manage sea ice at our scale.) For sandlance, which are not migratory, spawning is on sand, and no scale issues are known. Therefore sandlance production would be likely driven by large-scale issues even considering spawning habitat.

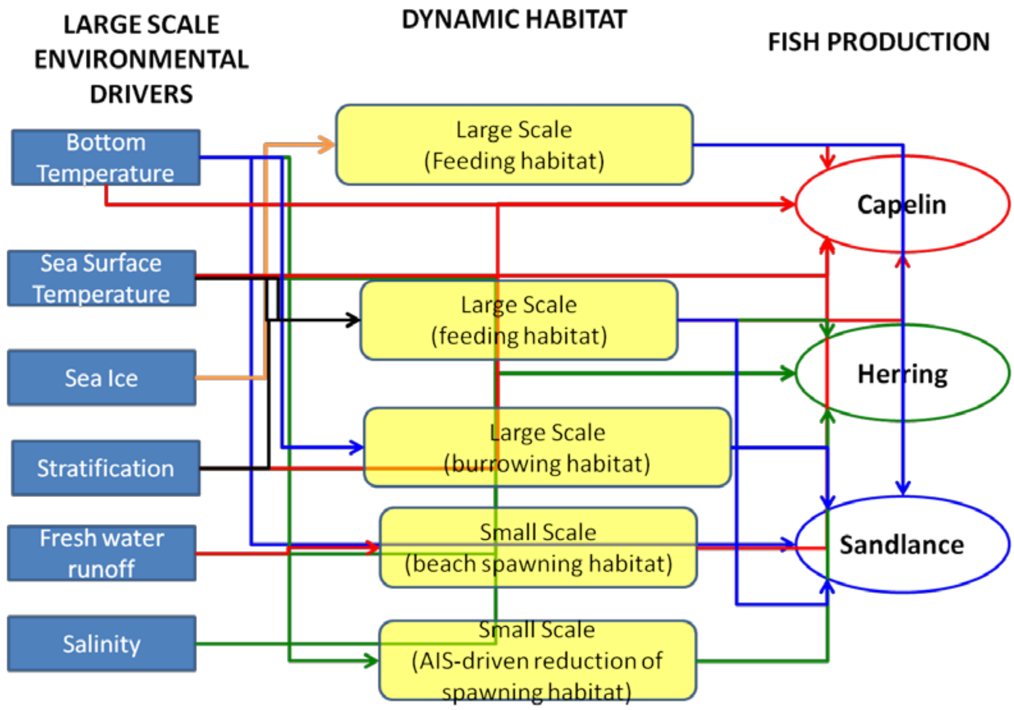

Figure 7. Second tier conceptual model linking environmental drivers with the forage fish ecosystem component. Multiple scales of linkages are identified.

Having completed this, the group agreed to fill out second tier models for all of the identified ecosystem and human system components (with respect to environmental drivers, human activities, and ecological interactions) prior to the next meeting for use as a tool informing MSE analysis.

5.2 Identifying and assessing indicators related to objectives, drivers, and multiscale responses

Working groups for the Canadian and US systems filled out the MSE Framework spreadsheet columns as described above (Figure 6 and Table 1). It was noted that in general, conservation objectives and indicator time-series aligned with focal ecosystem components, while human dimensions objectives and indicator time-series aligned with human activities. Therefore, to get the full range of linkages, focal ecosystem components and human activities need to be aligned in the spreadsheet (e.g. there may be recreational and commercial fishing as well as tourism applied to one focal ecosystem group, such that multiple human dimensions time-series and objectives are constrained by the productivity and environmental impacts on the focal ecosystem component.) An example in progress is shown in Table 2.

Table 2. Linking objectives, focal components, human activities, potential management measures and indicators.

High level goal	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production
Strategic objective	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production	Optimize food production
Operational objective								
Focal component (Ecological, biological, habitat, human)	Full Ecosystem	Groundfish	Forage fish	Fished invertebrates	Full Ecosystem	Groundfish	Forage fish	Fished invertebrates
Human activity (e.g. fishing, energy exploration, tourism, shipping)	Recreational fishery	Recreational fishery	Recreational fishery	Recreational fishery	Commercial fishery	Commercial fishery	Commercial fishery	Commercial fishery
Approach (general tools to achieve same operational objective; may not be necessary)								
Management tactic (measures, regulations applied to achieve operational objective; e.g. quota, effort limitation, best practice)	Recreational allocation of system level quota, prohibition on species below B threshold	Recreational allocation of aggregate quota, prohibition on species below B threshold	Recreational allocation of aggregate quota, prohibition on species below B threshold	Recreational allocation of aggregate quota, prohibition on species below B threshold	Commercial allocation of system level quota, prohibition on species below B threshold	Commercial allocation of aggregate quota, prohibition on species below B threshold	Commercial allocation of aggregate quota, prohibition on species below B threshold	Commercial allocation of aggregate quota, prohibition on species below B threshold
Indicator class (not specific time series)								
Indicator (specific time series including how indicator derived; e.g. model, survey)	Estimates of recreational fishing removals	Estimates of recreational fishing removals	Estimates of recreational fishing removals	Estimates of recreational fishing removals	Estimates of commercial food first point of sale	Estimates of commercial food first point of sale	Estimates of commercial food first point of sale	Estimates of commercial food first point of sale
Indicator data source								
Year range of indicator (but ideally apply ICES indicator evaluation criteria)	1981 - present	1981 - present	1981 - present	1981 - present	1990 - present	1990 - present	1990 - present	1990 - present
Spatial scale of indicator (but ideally apply ICES indicator evaluation criteria)								
Performance measure (Threshold, reference point, reference direction, and or hard constraint? Will not apply in all cases)	Total removal cap based on system production potential, no species below B threshold	Aggregate removal cap, considering flows within ecosystem, no species below B threshold	Aggregate removal cap, considering flows within ecosystem, no species below B threshold	Aggregate removal cap, considering flows within ecosystem, no species below B threshold	Total removal cap based on system production potential, no species below B threshold	Aggregate removal cap, considering flows within ecosystem, no species below B threshold	Aggregate removal cap, considering flows within ecosystem, no species below B threshold	Aggregate removal cap, considering flows within ecosystem, no species below B threshold
Legal basis/authority or agency/reference								
Additional comments/details								

The group also specified potential time periods to compare ecosystems that would be both compatible with available data across many types of indicators, but still show contrast in the large-scale drivers. Analyses in both systems were conducted to determine that a "historical" period from 1994–2000 could be compared with "current" conditions from 2010–2014 (Figures 8–11). This will facilitate comparisons using biological, ecological, social, and economic indicators, which are generally shorter time-series than the physical indicators in these ecoregions.

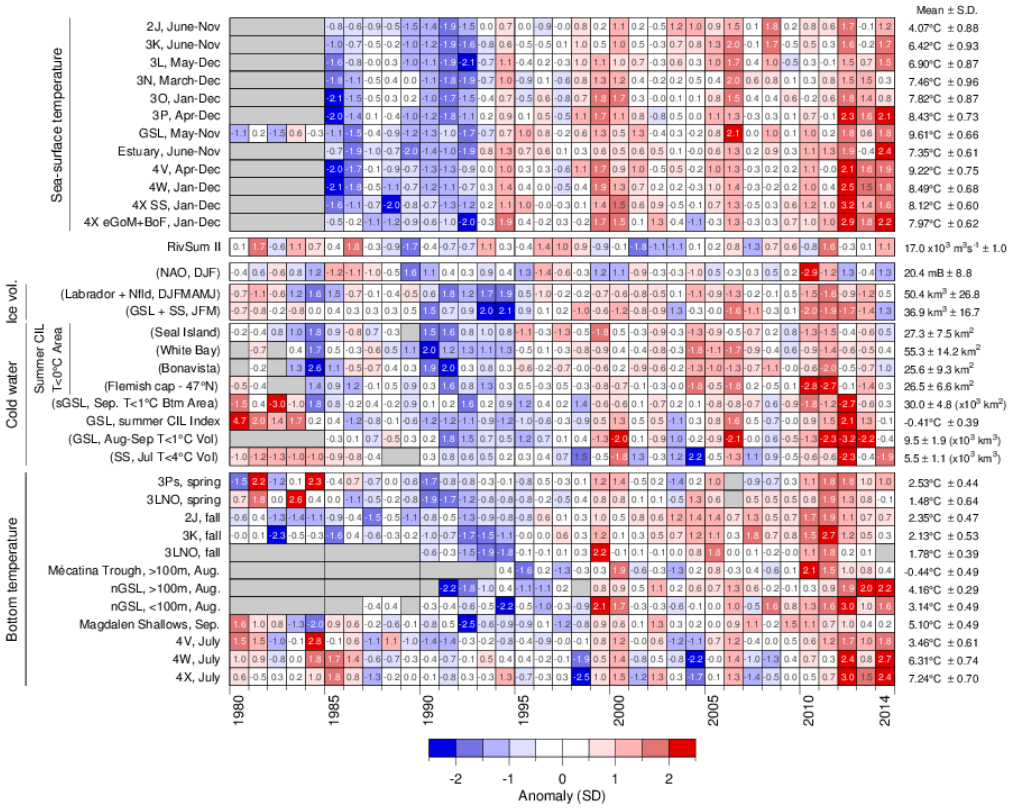

Figure 8. Analysis of physical drivers in Canadian ecoregions.

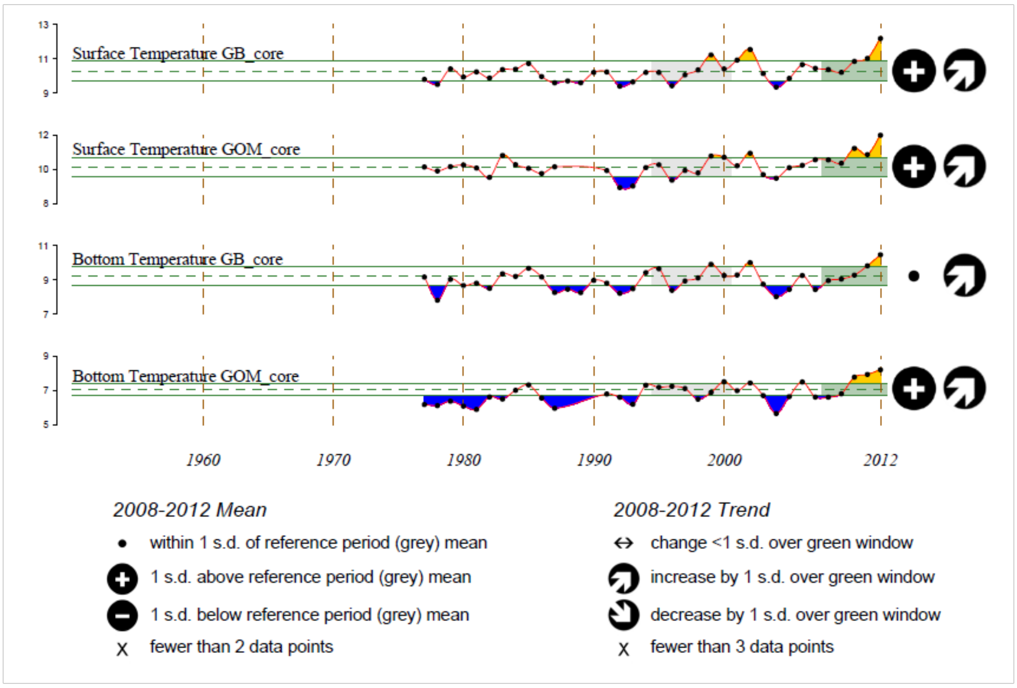

Figure 9. Comparison of historical and current signals in temperatures for Gulf of Maine and Georges Bank, US.

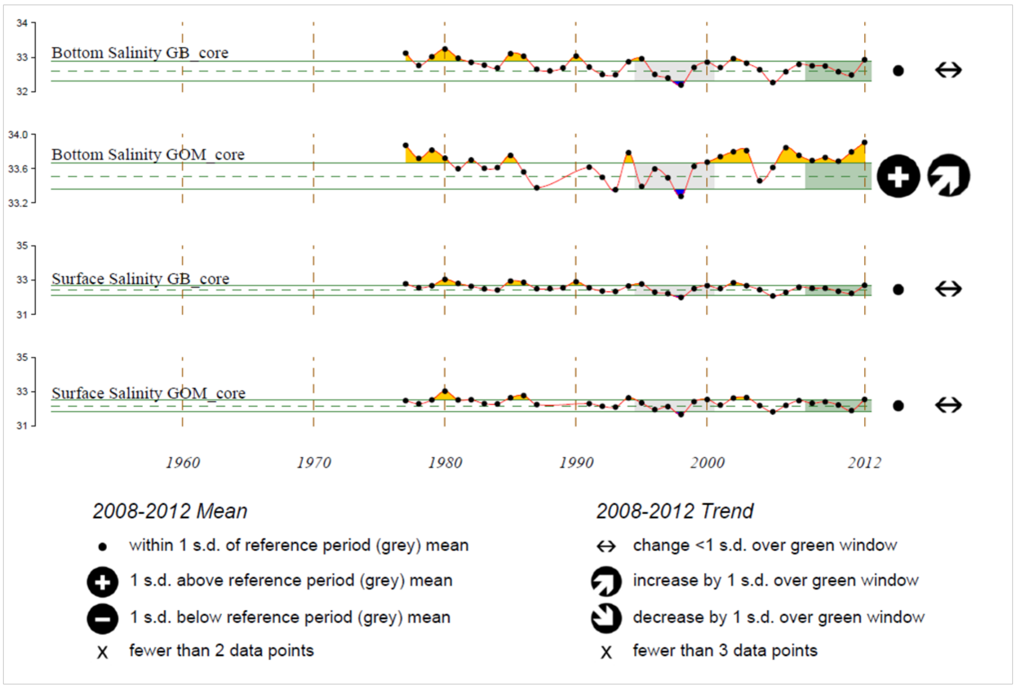

Figure 10. Comparison of historical and current signals in salinities for Gulf of Maine and Georges Bank, US.

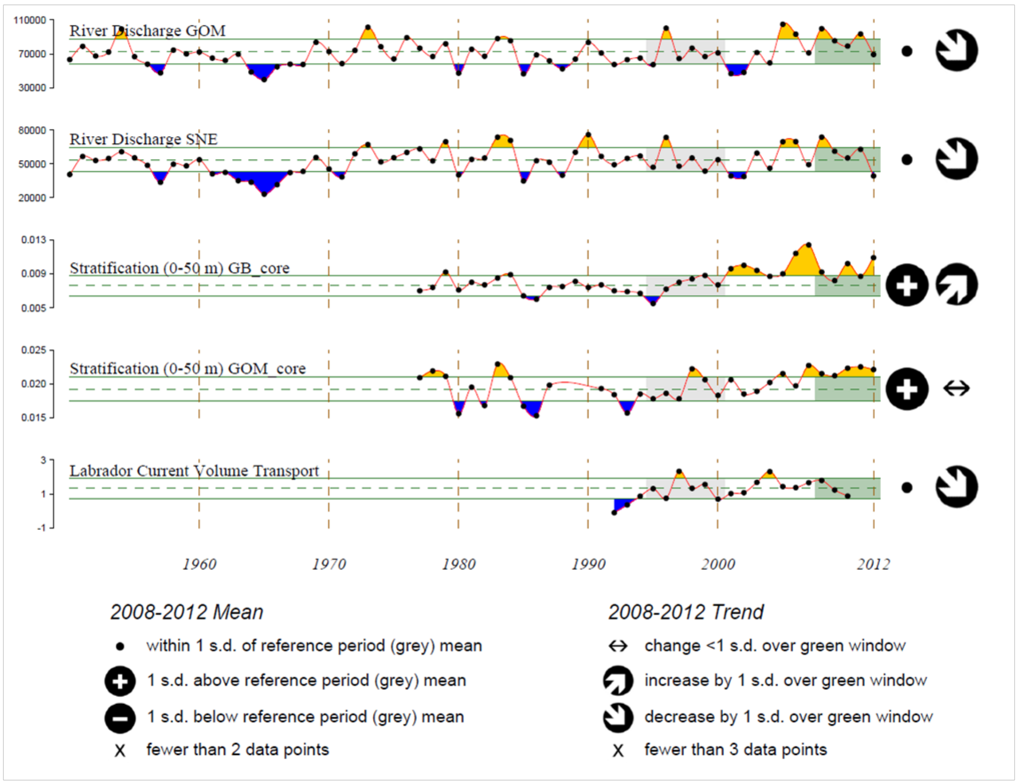

Figure 11. Comparison of historical and current signals in stratification and current volume transport for Gulf of Maine and Georges Bank, US.

6 Work plan developed by the group for 2016 meeting

On the final day of the meeting, the working group made a plan to complete the work started in 2015 and begin work necessary prior to the 2016 meeting to meet the three-year ToRs (see Annex 3).

WGNARS Workplan for 2015–2016

Task 1: Add energy sector expertise for the US (ASAP, Trish Clay and Sarah G.)

Task 2: Review of MSE methods/analytical frameworks used in IEAs work package (by September 2015)

Leads: Sean, MAYBE Becky

Contributors: anyone else interested.

Deliverables: Find and report on frameworks used elsewhere (California Current, Puget Sound, and other places). Present at next meeting, product for 2016 report. IEA lit may point to key references that we need to explore even if not IEA level MSE.

Task 3: Conceptual models work package (by June 2015)

Leads: Mariano/Alida and Sarah, responsible for organizing national groups and ensuring consistent development of conceptual models across national groups.

With: National groups including oceanographers, biologists, social scientists, managers, everybody.

Deliverables:

1. Conceptual models overall—done and in report, clean up for consistency
    a. Grand Banks (Canada)
    b. Gulf of Maine/Georges Bank (US)
2. Conceptual model linking large-scale drivers to ecosystem components
    a. Forage species, Canada and US—done and in report
    b. Do for other focal ecosystem components?—TO BE DONE
3. Conceptual models linking ecosystem components to other aspects of system—TO BE DONE
    a. Human activities
    b. Other ecosystem components (conservation objectives, including habitat)
    c. Human well-being (human dimensions objectives)
4. Get help on graphics to make conceptual models communicate most effectively to a wide variety of audiences (needs additional resources—but the UMD library of icons is available to be used.)

Task 4: Characterize conditions and indicators across time periods for MSE work package (prior to next WGNARS meeting in US, February 2016. Location and date finalized at ICES ASC). Schedule a call to clarify the task before starting.

Leads: Sarah, Melissa/Mariano; responsible for organizing national groups and ensuring consistent development of conditions/indicators for MSE analysis across national groups.

With: National groups including oceanographers, biologists, social scientists, managers, everybody.

Dependencies: Conceptual models. MSE framework spreadsheet. MSE methods for IEA review.

Deliverables:

Describe 1995–2000 conditions in Canada, US systems, including focal species (cod?), focal components, human activities, social and economic conditions. What management strategies have been applied?

Describe Current conditions in Canada, US systems same as above. And list of management strategies that could be applied.

1. Using complete conceptual models
    a. Identify all drivers, components, activities, key linkages
    b. Ensure that they have corresponding objectives/indicators in the MSE framework spreadsheet
2. Using complete MSE framework spreadsheet
    a. Assemble necessary time-series
    b. Assemble management tools into strategies (packages)
    c. Decide how to crunch numbers for analysis
        i. Mean over time period and variance?
        ii. Other ways—keep time-series?
        iii. Qualitative data? See below.

Things to consider:

1. Multiscale ecosystem responses:
    a. highlight in examples,
    b. continue to incorporate in conceptual models,
    c. note whether scale of indicators is appropriate for scale of focal component and/or human activity
2. Analytical needs: be able to work with different types of MSE inputs/outputs
    a. Quantitative indicators
    b. Quantitative models
    c. Qualitative models (conceptual models)
    d. Qualitative indicators
    e. Hard thresholds vs. reference directions

7 Conclusions

The group continued to make progress on identifying and operationalizing management objectives for a "worked example" IEA analysis for the Northwest Atlantic Regional Sea. Our primary advance this meeting was the development of conceptual models and frameworks to organize and structure our analyses. All of our work is advancing towards a comparative IEA-level management strategy evaluation between the selected Canadian and US ecoregions of the Northwest Atlantic Regional Sea in 2016. We drew the following conclusions, some of which indicate continuing areas for work in the next years.

We concluded that SMART objectives are helpful, but not desirable for all classes of objectives (i.e. social objectives) and/or managers need to determine what the specifics should be. Some objectives lend themselves to "physical" thresholds (e.g. constraints on ecosystem and species productivity), but not all. For human dimensions objectives, we can instead calculate means and variances where time-series of indicator data are available and then ask whether certain management measures or environmental conditions cause trends in these indicators, or cause them to move outside previously observed bounds.

We identified and discussed potential trade-offs between our objectives, and identified many different types of trade-offs: between objectives, between focal components, between human activities, industry sectors, etc. The MSE analysis will highlight these trade-offs.

We found that ICES indicator evaluation criteria are useful for indicator vetting, but do not apply well to all classes of objectives. They are designed for conservation objectives, and need modification for human dimensions objectives.

Habitat objectives and indicators may require different treatment like human dimensions objectives and indicators. We need to clarify how habitat functions as mediating components vs. management objectives for habitat itself; the conceptual models should help here. There continue to be many unknowns in relationship between habitat and fish which make specifying habitat's mediating role challenging.

Finally, we completed a list of common terminology and applied it within our MSE Framework spreadsheet. As we fill in the spreadsheet over the next year, we expect that further clarification may be necessary.

Annex 1: List of participants

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***Participated by teleconference**

DFO = Fisheries and Oceans Canada

IMR = Institute of Marine Research, Norway

NEFMC = New England Fishery Management Council

NOAA/NEFSC = National Oceanic and Atmospheric Administration / Northeast Fisheries Science Center, USA

NOAA/ST = Oceanic and Atmospheric Administration / Office of Science and Technology, USA

WHOI = Woods Hole Oceanographic Institute, USA

Annex 2: Agenda

ICES Working Group on the Northwest Atlantic Regional Sea

NAFO Headquarters, Dartmouth, NS, Canada

23–27 February 2015

Monday am: Travel/arrive	**Tuesday am:** **ToR d:** Mgt strategies Review objectives	**Weds am:** **ToR c:** Multiscale ecological responses, review large scale drivers	**Thurs am:** **ToR c:** Multiscale ecological response indicator selection, performance testing	**Fri am:** Wrap up, interim work/next steps
Monday pm: **ToR a—** review IEA progress for report	**Tuesday pm:** **ToR d:** Develop EBM strategies for analysis in MSE	**Wed pm:** **ToR c:** Identify multiscale ecological responses, list possible indicators	**Thurs pm:** **ToR d:** Refine mgt strategies given ToR c, identify MSE analytical tools	**Fri pm:** Adjourn/travel

Synopsis of workplan:
Review products from 2014 meeting and those completed prior to 2015 meeting:

- Example management objectives and indicators to evaluate system status relative to objectives
- Selected large-scale drivers for full region and associated indicators
- Based on these, continue to identify best practices and develop "worked example" IEA
- Identify multiple alternate management strategies that could achieve management objectives
- Discuss which indicators associated with management objectives may best represent system response to changes in large-scale drivers, and at what scale?
- Identify frameworks (ecosystem models, possibly risk assessment frameworks, etc.) to work towards IEA management strategy evaluation (to be done in 2016)

Agenda

Monday, 23 February 2015

Afternoon – Opening and Review (13:30 – 17:30)

ToR a) Develop the scientific support for an integrated assessment of the Northwest Atlantic region to support ecosystem approaches to science and management. Review and report on the work of other integrated ecosystem assessment activities in ICES, NAFO and elsewhere. Compile and provide guidance on best practices for each step of integrated ecosystem assessment.

Planned outcome: Brief interim report section updating other integrated ecosystem assessment activities, with components written by talk leads and context drafted by discussion leaders

Discussion led by Sarah Gaichas and Robin Anderson

13:30 Welcome and Introductions
13:45 Opening of the meeting
14:00 Sarah Gaichas – Background of WGNARS and overview of 3 year ToRs
14:20 Brief updates on integrated ecosystem assessment, only if new information
US--Rebecca Shuford /Mike Fogarty– Update on National and Northeast US IEA Activities
Canada – Heather Breeze, others: Update on National and regional activities
NAFO--Mariano Koen-Alonso – Update on IEA activities in the NAFO WGEAFM
Other relevant organizations

15:00 Break

15:20 Brief updates continued
16:00 Discussion of working sessions plan for days 2–4
17:30 Adjourn for Day

Tuesday, 24 February 2015

Morning –Ecosystem Based Management Strategies: Review objectives work (09:00 – 12:00)

ToR d) Identify alternative management strategies to achieve objectives (ToR b) based on drivers and responses at multiple scales (ToR c). Outline model requirements for management strategy evaluation.

Will review potential management tools and approaches for coordinating their use. Will operationalize ToR b objectives using indicator threshold analysis and risk analysis methods reviewed in 2013. Requires participation by managers and all scientists listed under ToR c.
List of operational objectives, alternative management strategies, and approaches for coordinating managment for NW Atlantic systems. Description of model requirements for MSE (2015).

Discussion leaders: Heather Breeze

09:00 Review lists of objectives from 2014, results of operationalizing objectives
Talks: all involved, Sarah/Geret to review US work; Catherine/Heather Canada

Discussion

10:30 Break

10:50 Continue SMART objectives review as necessary
Begin Discussion topic 3: ecosystem based management strategies for objectives

Plan for afternoon working session

12:30 Lunch

Afternoon - Ecosystem Based Management Strategies: Select for WGNARS (13:30 – 17:30)

13:30 Working session: Select working set of management strategies for WGNARS to work from

15:00 Break

15:20 Working session continued

17:00 Review working set of management strategies, summarize decisions for ToR d report

17:30 Adjourn for day

Wednesday, 25 February 2015

Morning – Multiscale ecosystem responses to large-scale drivers: identification (09:00 – 12:00)

ToR c) Identify key large-scale drivers that influence the whole NW Atlantic and how the ecosystem response varies at different spatial scales; select and vet indicators for these drivers and responses.

Will employ indicator performance testing and risk assessment methods reviewed in 2013 for both driver and response indicators. Requires participation by scientific experts in oceanography, habitat, biology, fisheries and other system uses, and socio-economics.

Expected deliverables: Short list of large-scale drivers and vetted set of indicators for changes in those drivers (2014). List of vetted indicators for key ecosystem responses at several scales (2015).

In 2015, we continue TOR c to examine multiscale responses to the large-scale drivers we identify this year. The drivers we identify and corresponding indicators that we test and vet in 2014 will also be used in analyses under TORs d and e in 2015–2016.

09:00 Sarah and all: Short overview of large-scale drivers and associated indicators selected from 2014 meeting, with any updates, clarifications, or new hypotheses.

10:00 Discussion—how can we select a representative range of multiscale responses to the combined large-scale drivers that explain substantial variation in the system with respect to objectives discussed under ToR b ? We cannot discuss them all.

e.g.: given the selected objectives and drivers with associated indicators, what are the most important responses to consider that represent a range of scales and potential cumulative effects/trade-offs for analysis within an IEA?

10:30 Break

10:50 Discussion continued, begin working session—finalize short list of key multiscale response that can be evaluated with indicators related to management objectives across WGNARS region

Strategy for afternoon session

12:30 Lunch

Afternoon - Multiscale ecosystem responses to large-scale drivers: available indicators (13:30 – 17:30)

13:30 Working session— finalize short list of key multiscale response that can be evaluated with indicators related to management objectives across WGNARS region

15:00 Break

15:20 Working session continued

17:00 Discussion

Next steps—evaluating the performance of the indicators, strategy for tomorrow

17:30 Adjourn for day

Group dinner—TBD

Thursday, 26 February 2015

Morning – Multiscale ecosystem responses to large-scale drivers: indicator selection and plans for performance testing (09:00 – 12:00)

ToR c continued) Identify key large-scale drivers that influence the whole NW Atlantic and how the ecosystem response varies at different spatial scales; select and vet indicators for these drivers and responses.

09:00 Briefly review indicator selection methods from 2014, thresholds and performance testing methods and results from 2013

09:30 Working session: finalize methods to apply to current set of indicators for multiscale ecosystem responses, when will we consider an indicator's performance acceptable?

10:30 Break

10:50 Working session continued

12:30 Lunch

Afternoon - Identify requirements for MSE: strategies, ecosystem drivers and responses (13:30 – 17:30)

ToR d continued) Identify alternative management strategies to achieve objectives (ToR b) based on drivers and responses at multiple scales (ToR c). Outline model requirements for management strategy evaluation.

13:30 Working session—review and refine candidate management strategies in light of ecosystem drivers and responses discussed under ToR c

15:00 Break

15:20 Working session continued—what are model requirements to complete MSE in 2016?

17:00 Discussion: what work still needs to be done? How to get it done prior to next meeting?

17:30 Adjourn for day

Friday, 27 February 2015

Morning – Review and wrap-up (09:00 – 14:00)

09:00 Review ToR products, continue or revise
Develop plan for follow-up and completion of report
Produce table of progress, plans, and gaps in the framework elements

10:30 Break

11:00 Review recommendations, develop abstracts for ICES ASC in Copenhagen
13:30 Final wrap-up

14:00 Adjourn meeting

Annex 3: WGNARS 2014–2016 Terms of Reference

2013/MA2/SSGRSP01 The **Working Group on the Northwest Atlantic Regional Sea (WGNARS)**, Co-chairs: Sarah Gaichas, USA, M. R. Anderson, Canada, will meet Falmouth, MA, USA XX–XX 2016.

	Meeting dates	Venue	Reporting details	Comments (change in Chair, etc.)
Year 2014	3–7 February April	Falmouth, USA	Interim report by 1 March 2014 to SSGRSP	
Year 2015	23–27 February	Dartmouth, NS, Canada	Interim report by 1 April 2015 to SSGIEA	
Year 2016	xxx - 2016	Falmouth, MA, USA	Final report by "DATE" to SSGIEA, SCICOM and ACOM.	

ToR descriptors

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
a	Develop the scientific support for an integrated assessment of the Northwest Atlantic region to support ecosystem approaches to science and management. Review and report on the work of other integrated ecosystem assessment activities in ICES, NAFO and elsewhere. Compile and provide guidance on best practices for each step of integrated ecosystem assessment.	a) Science Requirements: see below b) Advisory Requirements: none c) Requirements from other EGs: status updates from other groups employing IEA framework components.	1.1, 1.3, 1.4, 2.1, 2.4, 3.1, 3.2, 3.4	3 years	Summary review paper of lessons learned for IEAs in general and for each step of the process in the Northwest Atlantic using results from 2013, annual reviews of IEA activities, and ToRs b, c, d, e below (2016). Brief interim progress reports to ICES (2014, 2015).
b	Evaluate relationships among ecosystem level management objectives developed by past and current ecosystem based management frameworks for the NW Atlantic and identify candidate objectives for analysis.	Will employ scoping overview and qualitative mapping methods reviewed in 2013. Requires participation by managers.	3.1, 3.4	1 year (2014)	Conceptual model of relationships between current objectives, identifying which conflict. Candidate list of objectives for analysis (2014).

ToR	Description	Background	Science Plan topics addressed	Duration	Expected Deliverables
c	Identify key large-scale drivers that influence the whole NW Atlantic and how the ecosystem response varies at different spatial scales; select and vet indicators for these drivers and responses.	Will employ indicator performance testing and risk assessment methods reviewed in 2013 for both driver and response indicators. Requires participation by scientific experts in oceanography, habitat, biology, fisheries and other system uses, and socio-economics.	1.1, 1.3, 1.4, 2.1, 2.4	2 years (2014: identify drivers, vet key indicators; 2015: identify regional ecosystem responses, vet key indicators)	Short list of large-scale drivers and vetted set of indicators for changes in those drivers (2014). List of vetted indicators for key ecosytem responses at several scales (2015).
d	Identify alternative management strategies to achieve objectives (ToR b) based on drivers and responses at multiple scales (ToR c). Outline model requirements for management strategy evaluation.	Will review potential management tools and approaches for coordinating their use. Will operationalize ToR b objectives using indicator threshold analysis and risk analysis methods reviewed in 2013. Requires participation by managers and all scientists listed under ToR c.	3.1, 3.2	1 year (2015)	List of operational objectives, alternative management strategies, and approaches for coordinating managment for NW Atlantic systems. Description of model requirements for MSE (2015).
e	Evaluate ecosystem trade-offs using a range of simple management strategy evaluation (MSE) methods.	Will require regional models for capable of incorporating results of ToRs b, c, d. Requires participation by managers and all scientists listed under ToR c.	1.1, 1.3, 1.4, 2.1, 2.4, 3.1, 3.2, 3.4	1 year (2016)	Review of MSE methods available. Results of methods applied for NW Atlantic systems (2016).

Summary of the Work Plan

Year 1	Identify candidate ecosystem based management objectives and key large-scale ecosystem drivers (w/vetted indicators) in NW Atlantic.
Year 2	Identify key ecosystem responses to large-scale drivers at multiple scales (w/vetted indicators) and alternative management strategies based on candidate objectives (operationalized) and drivers/responses.
Year 3	Evaluate the ability of the alternative management strategies to achieve candidate operational objectives given large-scale drivers and multi-scale responses and report on trade-offs.

Supporting information

Priority	A regional approach to marine science is essential to address high priority research topics in the ICES Science Plan associated with understanding ecosystem functioning, particularly climate change processes (1.1), biodiversity (1.3) and the role of coastal-zone habitat in ecosystem dynamics (1.4), as well as understanding the interactions of human activities with ecosystems, particularly fishing (2.1) and impacts of habitat changes (2.4). Identifying potential objectives and evaluating alternative management strategies to achieve them addresses the development of options for sustainable use of ecosystems, specifically marine living resource management tools (3.1) and operational modelling combining oceanography, ecosystem, and population processes (3.2). Work identifying candidate ecosystem based management objectives and evaluating potential trade-offs through MSE contributes to socio-economic undestanding of ecosystem goods and services and forecasting the impact of human activities (3.4). Therefore, our workplan addresses all three thematic areas in the ICES Science Plan and multiple high priorities in each.
Resource requirements	Components of the integrated approach, such as ocean observation systems, ecosystem surveys, development of integrated modelling approaches and management objectives are being maintained by member countries, and the programme will coordinate and synthesize existing programmes.
Participants	The Group is normally attended by some 25–35 members and guests. However, expertise needed for each ToR differs so total participants over 3 years could be >50.
Secretariat facilities	Report preparation and dissemination
Financial	No financial implications.
Linkages to ACOM and groups under ACOM	During the development stage, there will be no direct linkages with advisory committees, but the integrated approach is expected to eventually support advice for implementing IEAs in NW Atlantic subregions, and may link to future ICES IEA advice in other regions.
Linkages to other committees or groups	There is a close working relationship with a number of the working groups and workshops under the Steering Group on Regional Seas, such as the Workshop on Benchmarking Integrated Ecosystem Assessments, and others within ICES, such as the Working Group on Marine Systems.
Linkages to other organizations	The NAFO Ecosystem Based Management Working Group has made progress toward similar objectives and will be a resource for collaboration.

Annex 4: Recommendations

Recommendation	Adressed to
1. Guidance should be developed on selection of thresholds and generally operationalizing objectives for Integrated Ecosystem Assessment	SSGIEA
2. WGNARS should meet XX XX 2016 in Falmouth, MA, USA	SSGIEA