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Northwest Atlantic Fisheries Organization



**Report of the NAFO Joint Commission-Scientific Council Working Group on
Ecosystem Approach Framework to Fisheries Management (WG-EAFFM) Meeting**

16-17 August 2018
London, United Kingdom

NAFO
Dartmouth, Nova Scotia, Canada
2018

Report of the COM-SC WG-EAFFM,
16-17 August 2018

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1. Opening by the co-Chairs, Andrew Kenny (EU) and Elizabethann Mencher (USA)

The meeting was opened by the co-Chair, Elizabethann Mencher (USA), at 09:30 hours on 16 August 2018 at the North-East Atlantic Fisheries Commission (NEAFC) Secretariat in London, United Kingdom. She thanked NEAFC Secretariat for the excellent facilities, welcomed the participants, and acknowledged the presence of observers (Annex 1). Brian Healey (Scientific Council Chair) acted as co-Chair of this meeting on behalf of Andrew Kenny (EU) who could not attend the meeting.

2. Appointment of Rapporteur

The NAFO Secretariat (NAFO Senior Fisheries Management and Scientific Council Coordinators) were appointed co-Rapporteurs for this meeting.

3. Adoption of Agenda

The agenda previously circulated was adopted with insertion of three subitems under “*Other Business*”:

- SponGES Presentation,
- Presentation on FAO and WCMC Areas Beyond National Jurisdiction (ABNJ) Deep Seas Project,
- Update on 2018 Performance Review.

4. Review of Commission response to recommendations of the 2017 WG-EAFFM meeting

It was noted that during the 2017 Annual Meeting, the delineation of the New England Seamount closure was revised based on the recommendation of this Working Group (WG). The new delineation is now reflected in the NAFO Conservation and Enforcement Measures (NCEM).

5. Report from the Secretariat on ongoing global processes

a. Sustainable Ocean Initiative (SOI) Global Dialogue with Regional Seas Organizations and Regional Fishery Bodies

NAFO Executive Secretary (Fred Kingston) informed the Working Group of his participation to the recent meeting of the SOI Global Dialogue with Regional Seas Organizations and Regional Fisheries Bodies. The complete meeting report is at <https://www.cbd.int/doc/c/eeeb/91a2/8082b4619ed1d8f02673652b/soi-om-2018-01-02-en.pdf>

The following are some of the meeting highlights (COM-SC EAFFM-WP 18-03 and 18-05):

- The 2nd Meeting of the Sustainable Ocean Initiative Global Dialogue with Regional Seas Organizations and Regional Fisheries Bodies on Accelerating Progress toward the Aichi Biodiversity Targets and Sustainable Development Goals was convened by the Secretariat of the Convention on Biological Diversity in Seoul from 10 to 13 April 2018. Financial support was provided by several government agencies. The meeting was organized in collaboration with the United Nations Environment Programme (UN-EP), the Food and Agriculture Organization (FAO) of the United Nations, and many other international and regional partners.
- Participants comprised representatives of Regional Seas Organizations (RSOs), Regional Fisheries Bodies (RFBs), including Regional Fisheries Management Organizations (RFMOs), and relevant United Nations/international organizations/initiatives as well as experts from national governments and agencies, and non-governmental organizations.

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- This meeting focused on the main objectives of the Sustainable Ocean Initiative (SOI) Global Dialogue, as set by its first meeting – enhancing cross sectoral collaboration among regional seas organizations and regional fisheries bodies, with a view to further strengthening their complementary roles in supporting national implementation of the Strategic Plan for Biodiversity 2011-2020 towards achieving the Aichi Biodiversity Targets and the relevant Sustainable Development Goals (SDGs).

b. Biological Diversity Beyond Areas of National Jurisdiction (BBNJ)

NAFO Executive Secretary (Fred Kingston) informed the Working Group of the ongoing processes on BBNJ (COM-SC EAFFM-WP 18-04).

To recall, in its resolution 69/292 of 19 June 2015, the General Assembly decided to develop an international legally binding instrument (ILBI) under the United Nations Convention on the Law of the Sea (UNCLOS) on the conservation and sustainable use of marine biological diversity of areas beyond national jurisdiction. To that end, it decided to establish, prior to holding an intergovernmental conference, a Preparatory Committee, open to all States Members of the United Nations, members of the specialized agencies and parties to the Convention, with others invited as observers in accordance with past practice of the United Nations, to make substantive recommendations to the General Assembly on the elements of a draft text of an international legally binding instrument under the Convention.

In 2018, the Executive Secretary attended in part both the third and the fourth (and last) sessions of this Preparatory Committee. The Executive Secretary also participated as a panelist in a side event to the fourth session of the Preparatory Committee that was organized by the FAO entitled “*Exploring a new instrument through the lens of Regional Fisheries Bodies (including Regional Fisheries Management Organizations)*”. At this side event, the Executive Secretary focused on the development of NAFO’s ecosystem approach framework to fisheries management.

6. Presentation and discussion on Scientific Council response to Commission request for advice in 2018:

The Commission Request pertaining to EAFFM-related topics were formulated in September 2017 during its Annual Meeting (NAFO COM Doc. 17-22). The SC Response to the Request was formulated at its June 2018 Meeting (SCS Doc. 18-19). The SC response to the EAFFM-related topics is largely based on the work of Working Group on Ecosystem Science and Assessment (WG-ESA) which met in November 2017 (SCS Doc. 17-21). Details of the SC response are contained in the two SCS documents.

a. Evaluation of the impact of scientific trawl surveys on VME in closed areas, and the effect of excluding surveys from these areas on stock assessments (request #6 in COM. Doc. 17-22).

Pierre Pepin, co-Chair of WG-ESA, presented the SC response pertaining to this request (see SCS Doc. 18-19, pp. 39-40). The Working Group was informed that SC considered an overview of all analysis conducted on this subject since the request was first raised during its 2015 meeting.

In 2016, SC (SCS Doc. 16-21) conducted an analysis of the spatial overlap of significant catches of VME indicator species in survey trawls from: (i) NAFO closed areas, (ii) areas inside the VME polygons, but outside closed areas, (iii) areas outside of closures and outside VME polygons. It was found that the vast majority of significant catches of VME indicator species - and the highest rate of such catches - occur in the areas covered by current closures.

In both 2016 and 2017, SC reviewed the consequences of excluding survey tows within the current closures to evaluate impacts on biomass indices for stocks assessed by SC. The results show minimal impact on estimates of survey biomass and trends for all the assessed species with the exception of roughhead grenadier and Greenland halibut. For these species the difference in biomass indices (with and without hauls in closed areas) is more noticeable, but the trends were similar to the original index.

Furthermore, an analysis of the length and age-disaggregated survey indices for these species was conducted for the Canadian survey data, and the results were indistinguishable. It was concluded that the impact of excluding the closed areas from future Canadian surveys would enhance protection of VME while not compromising the ability to determine stock status of NAFO-managed resources.

SC reiterates its recommendation in 2017 that scientific bottom trawl surveys in existing closed areas be avoided if possible and additional work be conducted as soon as possible to further evaluate the implications of excluding RV surveys in closed areas on stock assessment metrics.

SC noted that trawl survey data have been used both for the provision of fish stock abundance indices and for identification of Vulnerable Marine Ecosystems (VME). In order to continue monitoring of VME and fish stocks in closed areas, it will be necessary for Contracting Parties (CPs) to consider plans for the deployment of non-destructive surveying methods (e.g. camera surveys).

The Working Group discussed alternative surveying methods and noted that a period of comparative surveying will be required to ensure calibration between the new and old methods. Some CPs also noted that the scientific trawl studies were helpful in identifying areas with VME indicator species.

A recommendation of the Working Group in relation to this agenda item is given in Section 9 of this report.

b. Guidance on the implementation of an ecosystem approach and application of the Ecosystem Approach to Fisheries (EAF) Road Map, through examples of how advice compares to single species stock assessment, including additional factors to be considered and integrating trophic level interactions and climate change predictions (request #9 in COM Doc. 17-22).

Pierre Pepin, co-Chair of WG-ESA, presented the SC response pertaining to this request (see SCS Doc. 18-19, pp. 41-51).

On the implementation of an ecosystem approach and application of the EAF Road Map, SC produced example ecosystem-level advice for 3LNO Grand Bank Ecosystem Production Unit (EPU). The ecosystem-level advice provides synoptic overview of both ecological features and management measures at the level of each EPU, i.e. Flemish Cap, Grand Banks and Newfoundland Shelf. The concept of Total Catch Ceiling (TCC), first introduced to WG-EAFFM in 2015 (see FC-SC Doc. 15-03), was presented and discussed.

The Ecosystem Summary Sheets (ESS) reports on each of the major EPU. Summaries consist of two element groups: 1) measures of state (oceanographic, production, ecological features) and species interactions within each EPU; and, 2) relationship of the state variables relative to management framework and objectives. The ESSs are provided with the general principles of the new Convention of long-term sustainability of fisheries resources, best scientific advice, precautionary approach, etc., in mind. ESS should be carried at medium-term intervals (3-5 years). Annex 3 provides an example of an ecosystem-level advice and the accompanying ESS and narrative on ecological features and management measures. It was emphasized by SC that it is not an actual advice but an illustration of how the SC advice would look like.

Some comments and discussion points that arose from the presentation are presented below and they are not necessarily the consensus among the scientists and managers:

- Given the complications of ecosystems, the ESSs are helpful as it gives a balance of simplification and important information.
- The ESS is appropriate to provide overview. No missing or redundant elements were identified. Many participants noted that available manpower and expertise was a factor, and there was no consensus on completing the ESS for other EPUs.
- The challenge of translating the advice into practical management measures was noted. For example, if the TCC (as an indicator or limit) is reached or productivity is declining, there would be an impact on the TAC of each of the managed stocks (as listed in Annex I.A in the NCEM) that could require a management action. In addition, it was noted there were other specific challenges related to multispecies management including possible implications for existing allocations, considerations of highly migratory species, implications for species managed by other RFMOs and others.
- Participants discussed that there could be a range of uses for the TCC and associated ESSs, including as tool to warn managers of long-term declines in stock and ecosystem health.

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- Caution must be exercised in the use of terms, e.g. ceilings, limits, and overfishing etc. For example, “overfishing” in the context of single stock assessment is understood to have a specific meaning in relation to exceeding Maximum Sustainable Yield.
- The Working Group will have to meet via Web-Ex before the scheduled WG-ESA meeting in November, to resolve the issue of terminologies. The co-Chair of WG-ESA invited managers to attend the November WG-ESA meeting to assist in the validation of models used in the formulation of ESS.
- Some CPs indicated that the concept of TCC must be revisited.
- The Working Group noted the need to think carefully about next steps and specifically how this information could potentially be used. The Commission must reflect on what direction it needs to take and provide specific and concrete advice to inform the work of the SC. It was suggested that this could be discussed at the upcoming Commission-SC session at the Annual Meeting in September.

The presiding co-Chair, Elizabethann Mencher (USA), summed up the discussions: There needs to be consensus on terminology, and the process of the provision of advice needs to be fine-tuned before the Commission can decide how to handle the ecosystem-level advice. In moving forward, the Working Group made some recommendations in relation to this agenda item and they are presented in Section 9 of this report.

7. Discussion of ongoing matters:

a. Progress towards the 2021 re-assessment of the impacts of NAFO bottom fisheries (request #10 in COM. Doc. 17-22).

Pierre Pepin, co-Chair of WG-ESA presented the SC response pertaining to this request which comprises four components (see SCS Doc. 18-19, pp. 52-54):

i. *Assessment of the overlap of NAFO fisheries with VME.*

SC made further progress in assessing the overlap of NAFO fisheries with VME through an analysis of haul-by-haul log-book data in combination with VMS data. Such analysis significantly improves the spatial definition of specific fishing areas within the NAFO footprint. SC recommends: the dimensions of the door spread of fishing gear is required for the estimation of swept area calculations, and this should be added to Annex II.M, 1B standardized observer report template for trawl gear information.

ii. *Objective weighing criteria for the assessment of Significant adverse impact (SAI).*

Objective ranking processes and weighting criteria for the overall assessment of SAI can only be completed once work towards advancing the assessment of all six of the FAO criteria for the next reassessment has concluded.

iii. *Maintaining efforts to assess the six FAO criteria (Article 18 of the FAO International Guidelines for the Management of Deep Sea Fisheries in the High Seas).*

SC made progress in developing models and methodological approaches which assess the functional significance of VMEs and the estimation of recovery rates of different VME indicator species. In addressing criteria IV, SC continues to develop and refine methodological approaches that can provide an estimate of the rates of VME recovery and resilience. SC has initiated a biological traits analysis to help determine the functional significance of VMEs that will help to address FAO criteria V.

iv. *Continuation of work on non-sponge and non-coral VMEs (for example bryozoans and sea squirts).*

SC updated analysis (including new data) on non-coral and non-sponge VME indicator species and further work is planned on defining non-coral and non-sponge VMEs ahead of the re-assessment of VME fishery closures in 2020.

The Working Group endorsed that the SC and WG-ESA advance the work on the FAO six criteria and further noted that NAFO's significant advancements in this work would be of use to other Regional Fisheries Management Organizations (RFMOs). A recommendation of the Working Group in relation to this agenda item is given in Section 9 of this report.

Regarding the fishing gear recommendation by SC to collect and report additional information trawl door spread to assist in the implementation of the six FAO criteria, the SC Chair will consult with the Secretariat and the STACTIC Chair to determine what information on door spread is currently being collected, and if that information is being digitized, and is available to the SC. This information will be collated in advance of the 2018 Annual Meeting, informing the way forward with respect to the SC recommendation regarding the 2021 reassessment process of NAFO bottom fisheries.

b. Review of area closures, including area #14 (NAFO CEM Article 17.3.b)

According to Article 17.3.b of the NCEM, Area 14, an area with significant concentrations of sea pens, is closed to bottom fishing activities until 31 December 2018.

To help inform the Commission in deciding on management measures after 2018, SC conducted an updated analysis with additional sea pen biomass records (2014-2017). SC concludes that there is very little change in the overall distribution of sea pen VME found on the eastern area of the Flemish Cap (see SCS Doc. 18-10, pp. 86-87).

There was no clear consensus within the Working Group regarding the status of Area 14 closure beyond December 31, 2018. Some members of the Working Group suggested extending the closure through 2020 to align with the other NAFO closed areas and reflecting the precautionary approach. Several Contracting Parties (CPs) noted the need for additional information from the SC on the status on the resilience of sea pens, as part of the Article 18 criteria of the FAO Guidelines for the Management of Deep Sea Fisheries in the High Seas. There was a number of divergent views offered by CPs including continuing the closure, suspending the closure until the 2020 review, and discontinuing it. Several CPs noted the need to consult further internally on this issue. It was agreed that Area 14 would be included in the 2020 closure review.

The Working Group was unable to come to consensus on the status of the Area 14 closure, and as such, it will require a decision from the Commission at its September 2018 meeting. A recommendation of the Working Group in relation to this agenda item is given in Section 9 of this report.

8. Other Business

a. Adoption of FAO 3-alpha codes for VME indicator species

The NAFO Commission Ad Hoc Working Group to Reflect on the Rules Governing Bycatches, Discards and Selectivity in the NAFO Regulatory Area (WG-BDS) met in May 2018 and recommended that the Secretariat, in conjunction with STACTIC and WG-EAFFM, develop tools to cross-reference the relevant FAO 3-alpha code with the VME indicator species, set out in Annex I.E of the NCEM to facilitate their inclusion in observer and haul by haul catch reports.

The Working Group reviewed the VME species lists in Annex I.E of the NCEM and in the *Coral, Sponge, and Other Vulnerable Marine Ecosystem Indicator Identification Guide, NAFO Area* (ID Guide). It was noticed that 3-letter FAO alpha codes of the species, which would facilitate the catch reporting of the VME indicator species, are not indicated in NCEM or in the ID Guide.

Recommendations of the Working Group in relation to this agenda item is given in Section 9 of this report.

b. SponGES Presentation

A presentation was given by Dr. Ellen Kenchington on the EU Horizon 2020 Framework project SponGES. The project is funded under the Blue Growth call “*Improving the preservation and sustainable exploitation of Atlantic marine ecosystems*” and has brought together more than 20 institutions in a partnership to undertake research on deep-sea sponges and sponge grounds. SponGES is linked to the Galway Statement, a research alliance between the EU, USA and Canada, and the project coordinators are Prof. Hans Tore Rapp (Norway), Prof. Shirley Pomponi (USA) and Dr. Ellen Kenchington (Canada), reflecting this agreement.

SponGES covers a wide range of research topics aimed at gaining new knowledge on the basic biology and ecology of these organisms, improving innovation and predictive capacity, developing tools for conservation and exploitation, and translating the science to managers and policy makers through annual meetings such as this Working Group. The presentation focused on the new research being done which will inform management

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decisions in NAFO. Major research efforts that are expected to be available through peer reviewed publications prior to the 2020 review of the closed areas are: biodiversity, connectivity (informed by new knowledge on the reproduction and genetics of key species and the oceanographic settings of the sponge grounds), fish associations, habitat modelling, and the ecosystem functioning of sponge grounds. The latter includes in situ and laboratory experiments on the utilization of nutrients (Si, N, P) and dissolved and particulate organic carbon by sponges, their respiration and filtration rates. These results will be used to estimate the significant adverse impact of fishing in the NRA. Further, work is being undertaken to look at the impacts of longline and trawl fishing on the removal of sponges according to their shape and size (morphotype), and of the recovery of areas known to have been trawled at a certain time. Experiments exposing the sponges to sediments as well as to temperatures and pH associated with climate change will help to assess the impact of these stressors on the sponge grounds.

The presentation also highlighted SponGES research in the fields of blue growth, particularly in the areas of marine-derived chemicals with pharmaceutical applications and in bone tissue engineering and regenerative medicine. Recent capacity building workshops for sponge identification were outlined and the supporting pamphlets produced by FAO (and their download links) which provide an overview of the project were presented to the group. A number of questions were raised concerning the research and the Working Group expressed their appreciation for the presentation and were pleased to see how the work was integrating well with the work of WG-ESA and well-timed to assist with management decisions.

c. Presentation on FAO and WCMC Areas Beyond National Jurisdiction (ABNJ) Deep Seas Project

William Emerson, Project Coordinator of the FAO Common Oceans Deep Seas Project, informed the Working Group about the ABNJ project.

FAO and the United Nations Programme Environment World Conservation Monitoring Centre (WCMC) provided an overview of the ABNJ Deep Seas Project (<http://www.fao.org/in-action/commonoceans/projects/deep-seas-biodiversity/en/>) and activities related to the Project. The Deep Seas Project is a 5-year GEF funded project. The project's aim is to *"enhance sustainability in the use of deep-sea living resources and biodiversity conservation in the ABNJ through the systematic application of an ecosystem approach"*.

This project focuses on four areas:

1. Improving implementation of policy and legal frameworks for sustainable fisheries and biodiversity conservation of deep seas in the ABNJ (FAO)
2. Reducing adverse impacts on VMEs and enhanced conservation and management components of EBSAs (FAO)
3. Improving planning and adaptive management for deep sea fisheries in ABNJ (FAO)
4. Developing and testing of a methodology for area-based planning (WCMC)

FAO and WCMC also introduced the side events they will host at the BBNJ meeting in New York. These include:

- Deep seas sponges and other biodiversity in the ABNJ: advances in research and information and implications for management (FAO)
- 10 years of the FAO Deep Seas Fishers Guidelines (FAO)
- Area based planning tools (WCMC)

d. Update on 2018 Performance Review

NAFO Executive Secretary (Fred Kingston) informed the Working Group that the 2018 Performance Review has concluded. The Review Panel will present its report to the Commission at the September 2018 NAFO Annual Meeting in Tallinn, Estonia.

9. Recommendations to forward to the Commission and Scientific Council

The WG-EAFFM recommends that:

- In relation to the evaluation of impact of scientific trawl surveys on VMEs in closed areas, Contracting Parties consider possible options for non-destructive regular monitoring within closed areas, bearing in mind cost implications and the utility of data collected for provision of advice.
- In relation to implementation of the Ecosystem Approach Roadmap, WG-EAFFM continue to make progress on the Ecosystem Approach Roadmap, acknowledging the general concepts of Ecosystem Production Potential (EPP) as a useful step towards implementation of EAFFM.

The Scientific Council continue to refine its work under the ecosystem approach road map, including testing the reliability of the ecosystem production potential model and other related models, and to report on these results to the WG-EAFFM to further develop how it may apply to management decisions.

WG-EAFFM work to reconsider the terminology used in the Ecosystem Summary Sheets in order to avoid potential confusion with standard terminology in fisheries management, as well as considering their potential ability to inform management decisions.

- In relation to the area #14, the Scientific Council include it in its review of closed areas in 2020, irrespective of the decision on continuing or not this closure after 2018, which remains to be considered by the Commission.
- In relation to the assessment of significant adverse impacts (SAI), SC maintain efforts to assess all of the six FAO criteria, including the three FAO functional SAI criteria (Article 18 of the FAO international Guidelines for the management of deep-sea fisheries in the High Seas) which could not be evaluated in the current assessment.
- In relation to FAO three letter codes for VME indicator species, the existing taxa list in Annex I.E. Part VI of the NCEM be updated with the FAO ASFIS codes as listed in Annex 4 of this report.

The Scientific Council review the proposed revisions to Annex I.E. Part VI as reflected in COM-SC EAFFM-WP 18-01, and to compare the consistency of the list of taxa in that Annex to the VME species guide with a view to recommend updates, as necessary.

The Secretariat to work with the FAO to develop new ASFIS codes, as necessary, for those taxa listed in Annex 1.E Part VI.

10. Adoption of Report

The report was adopted via correspondence.

11. Adjournment

The meeting was adjourned at 12:00 hours on 17 August 2018.

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Annex 1. List of Participants

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Annex 2. Agenda

1. Opening by the co-Chairs, Andrew Kenny (EU) and Elizabethann Mencher (USA)
2. Appointment of Rapporteur
3. Adoption of Agenda
4. Review of Commission response to recommendations of the 2017 WG-EAFFM meeting
5. Report from the Secretariat on ongoing global processes
 - a. Sustainable Ocean Initiative (SOI) Global Dialogue with Regional Seas Organizations and Regional Fishery Bodies
 - b. Biological Diversity Beyond Areas of National Jurisdiction (BBNJ)
6. Presentation and discussion on Scientific Council response to Commission request for advice in 2018:
 - a. Evaluation of the impact of scientific trawl surveys on VME in closed areas, and the effect of excluding surveys from these areas on stock assessments (request #6 in COM. Doc. 17-22).
 - b. Guidance on the implementation of an ecosystem approach and application of the Ecosystem Approach to Fisheries (EAF) Road Map, through examples of how advice compares to single species stock assessment, including additional factors to be considered and integrating trophic level interactions and climate change predictions (request #9 in COM Doc. 17-22).
7. Discussion of ongoing matters:
 - a. Progress towards the 2021 re-assessment of the impacts of NAFO bottom fisheries (request #10 in COM. Doc. 17-22).
 - b. Review of area closures, including area #14 (NAFO CEM Article 17.3.b)
8. Other Business
 - a. Adoption of FAO three letter codes for VME indicator species
 - b. SponGES Presentation
 - c. Presentation on FAO and WCMC Areas Beyond National Jurisdiction (ABNJ) Deep Seas Project
 - d. Update on 2018 Performance Review
9. Recommendations to forward to the Commission and Scientific Council
10. Adoption of Report
11. Adjournment

Annex 3. Ecosystem-level advice on The Grand Bank (3LNO) Ecosystem Production Unit: An Example

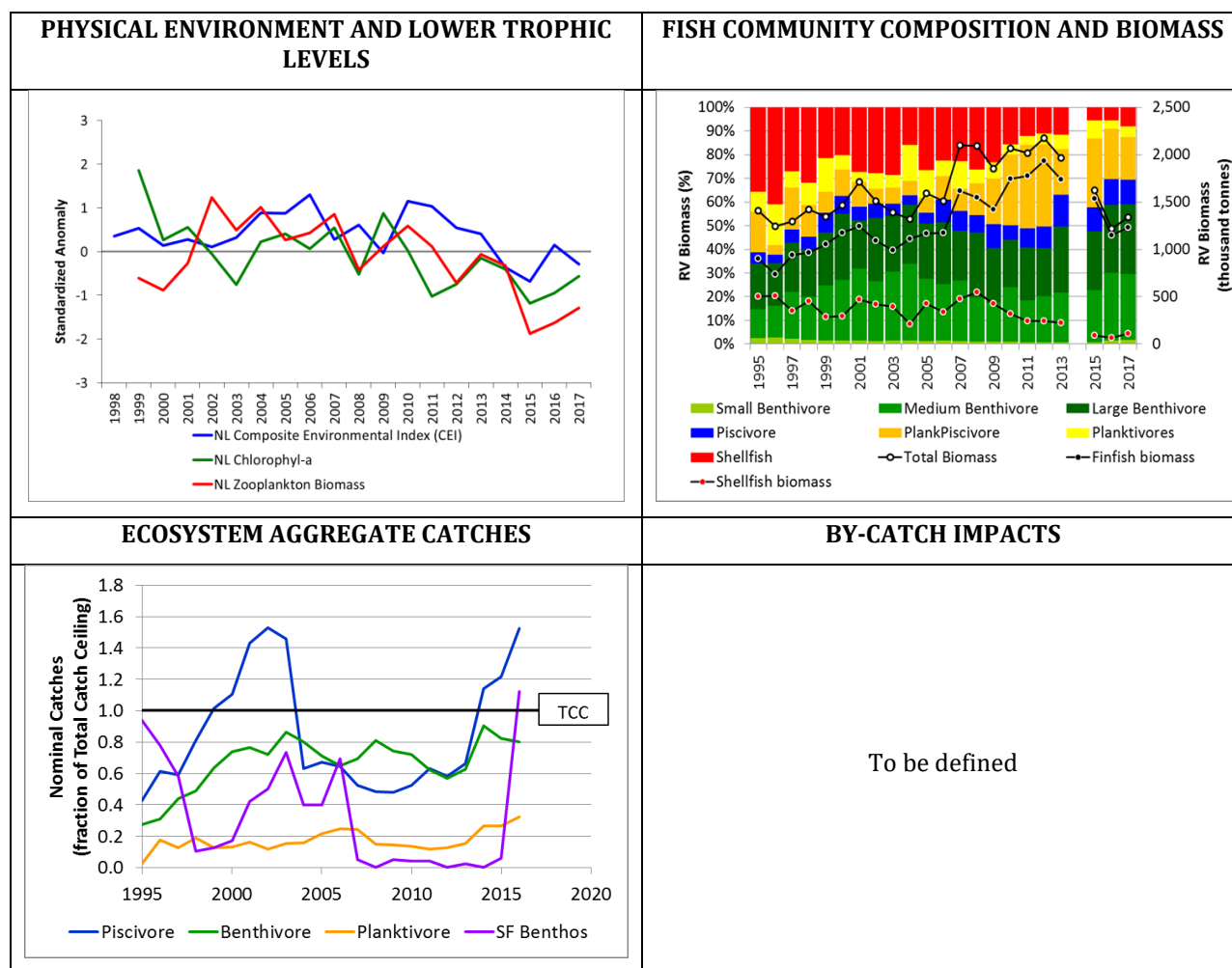
Example recommendation: The Grand Bank (3LNO) EPU is currently experiencing low productivity conditions and biomass declines across multiple trophic levels and stocks. Although reduced productivity appears to be driven by bottom-up processes, current aggregate catches for piscivore species have been increasing and exceeding the guideline level for ecosystem sustainability. Reductions in piscivore catch levels are recommended.

ECOLOGICAL FEATURES					
Convention Principle			Comment		
a	Ecosystem status and trends (long-term sustainability)		S	T	Summary of state (S) and trend (T)
	1	Physical Environment			No clear 5-yr trend but notable 10-yr cooling trend
	2	Primary Productivity			Reduced nutrients, phytoplankton standing stocks and productivity.
	3	Secondary Productivity			Reduced total zooplankton biomass, with increased abundance of small-sized taxa.
	4	Fish productivity			Declines in total, finfish, and shellfish biomass across all functional feeding groups since 2013-14. Overall biomass below pre-collapse levels.
	5	Community composition			Shellfish has declined in dominance, but piscivores have yet to regain their pre-collapse dominance.
b	Ecosystem productivity level and functioning				Summary of state (S) and trend (T)
	1	Current Fisheries Production Potential			Total biomass further declined from 50% to ~30% of the estimated pre-collapse level.
	2	Status of key forage components			Reduced levels of capelin, sandlance, arctic cod, and shrimp.
	3	Signals of food web disruption			Diet composition variable of key predators (cod and turbot), declining trend in stomach content weights.
e	State of biological diversity				Summary of indicators
	1	Status of VMEs			Metrics to quantify VME state and change of state in recent period need to be developed.
	2	Species depletion			Proportion of depleted species (<20% of maximum) based on survey indices. Work in development.
MANAGEMENT MEASURES					
Convention Principle			Comment		
c/d	Precautionary Aspects		S	T	Summary of metrics on level of management action
	1	Total Catch Ceilings (TCC) and catches			Indications of ecosystem overfishing. Piscivores catches have been exceeding their TCC; suspension-feeding benthos exceed it in 2016.
	2	Multispecies and/or environmental interactions			No explicit consideration of species interactions and/or environmental drivers.
	3	Production potential of single species			Only 60% of managed stocks are supporting fisheries; some stocks have declining abundance trends.
d/e	Minimize harmful impacts of fishing on ecosystems				Summary of metrics on level of management action

	1	Level of protection of VMEs			Some VMEs without protection. Protection has improved. Fishing does not intrude in closed areas.
	2	Level of protection of exploited species			Total Catch Ceilings have been developed; 70% of managed stocks have LRPs or HCRs, but some stocks only have survey-based LRPs; No multispecies assessment are in place.
d/f		Assess significance of incidental mortality in fishing operations			Summary of metrics on level of management action
	1	By-catch level across fisheries			Integrative indicators/analyses need to be developed.
	2	By-catch of depleted species			Integrative indicators/analyses need to be developed for non-target taxa. This should include listed species.
CONSIDERATIONS OF SPECIAL CONCERN (outside mandate of NAFO Convention)					
		Human Activities other than fisheries			Comment
	1	Oil and gas activities			There are four offshore production fields on the Grand Bank and intense exploration activities along the eastern shelf break and Flemish Pass.
	2	Pollution			...
	3	...			...

Figure. Upper left-hand panel shows anomalies of the standardized composite environmental index (blue), composite index of chlorophyll *a* abundance (green) and the composite index of zooplankton biomass (red). Upper-right panel shows the relative composition of the fish and shellfish community functional feeding groups derived from research vessel trawl surveys (colour bars – referenced to the left axis with the legend at the bottom) and the total, finfish and shellfish biomass (referenced to the right axis). Lower left-hand panel shows the nominal total catch of functional groups (estimated from STATLANT21A data) scaled relative to the Ecosystem Production Potential model-derived Total Catch Ceilings estimates disaggregated for each functional group. The content of the lower-right panel has yet to be determined.

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3LNO EXAMPLE Ecosystem Status Narrative

ECOLOGICAL FEATURES

Ecosystem Status and Trends

The last 5 years have been characterized by reduced levels of nutrients, phytoplankton standing stock and primary production, and total zooplankton biomass. Reduction in zooplankton biomass has been accompanied with changes in the composition of the zooplankton community, with small-sized taxa having significantly increased in abundance while the larger, lipid-rich taxa have declined. Since 2013, total fish biomass has lost the gains built-up since the mid-1990s. Fishes have increased their dominance in the community at the expense of shellfish, but the piscivore functional group has not regained its pre-collapse dominance.

Ecosystem productivity level and functioning

The Grand Bank is experiencing low productivity conditions. After the regime shift in the late 1980s and early 1990s, this ecosystem never regained its pre-collapse level. Improved conditions between the mid-2000s and early 2010s allowed a build-up of total biomass up to ~50% the pre-collapse level. This productivity was associated to good environmental conditions for groundfish, and modest increases in forage species (capelin). Since 2013, forage species have declined, and a reduction in total biomass to ~30% of pre-collapse levels has occurred across all fish functional groups. Although variable, diet composition of cod suggests reduced contributions of forage species, and average stomach content weights of cod and Greenland halibut have shown declines, suggesting poor foraging conditions.

State of biological diversity

Biological diversity is a multi-faceted concept. Out of its many dimensions, assessment of its state is being limited to Vulnerable Marine Ecosystems (VMEs) and the number of fish species considered depleted. Although identification and delineation of VMEs is being done, it is difficult to assess their status given the absence of a defined baseline and the unquantified impacts from historical fishing activities. Work on metrics to assess VME state and the evaluation of depleted species is ongoing, but results are not yet available.

MANAGEMENT MEASURES**Precautionary Principles**

The NAFO Roadmap addresses sustainability of fishing at three nested levels of ecosystem organization: ecosystem, multispecies and stock levels. Catches of piscivore species have been above their Total Catch Ceiling (TCC) in the past, are currently increasing, and since 2014 are once again above their TCC, indicating overfishing at the ecosystem level. Catches for suspension feeding benthos were also above their TCC in 2016. Only 60% of the NAFO managed stocks in the Grand Bank are in conditions of supporting fishing, and some of these stocks are showing declining trends. Impacts of species interactions and/or environmental drivers are not currently being considered in advice or management.

Minimize harmful impacts of fishing on ecosystems

Minimization of harmful impacts of fishing on benthic communities has been focused on the protection of VMEs. Many coral and sponge VMEs in the Grand Bank are currently protected with dedicated closures, but the 30 coral closure does not provide protection for the identified VMEs in that area. Other non-coral/sponge VMEs have been identified in the tail of the Grand Bank but remain unprotected because of difficulties in delineation of areas of high concentration at appropriate spatial scales.

At the ecosystem level, Total Catch Ceilings for this ecosystem have been developed. At the stock level, 70% of managed stocks have LRPs or HCRs, although some LRPs are based on survey indices. At this time, there are no multispecies assessments to inform on trade-offs among fisheries, and no stock-assessment explicitly considers species interactions and/or environmental factors as drivers, but there is ongoing work on these issues.

Assess significance of incidental mortality in fishing operations

By-catch limits and move-on measures are in place for some fisheries, but there is no integrated assessment of by-catch in fisheries operations and their potential impact at the ecosystem scale. There are no dedicated measures to quantify and manage by-catch of listed species. Additional work on these topics is required.

OTHER CONSIDERATIONS**Human activities other than fishing**

There are four offshore oil and gas fields currently in production in the southern Grand Bank, and exploration activities are ongoing along the eastern shelf break of the Grand Bank and the Flemish Pass. Exploration activities involve seismic surveys and exploratory drilling.

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Annex 4. FAO ASFIS 3-alpha FAO codes of VME indicator species

The following table lists the current NAFO VME Indicator Species as found in Annex I.E Part VI. Of the NAFO CEM with the available ASFIS 3-Alpha codes.

Benthic Invertebrate VME Indicator Species			
Common name of taxonomic group	Known Taxon	Family	Phylum
Large-sized sponges (SPO)			Porifera
	<i>Iophon piceum</i> (WIP)	Acarinidae	
	<i>Stelletta normani</i>	Ancorinidae	
	<i>Stelletta</i> sp. (WSX)	Ancorinidae	
	<i>Stryphnus ponderosus</i>	Ancorinidae	
	<i>Axinella</i> sp.	Axinellidae	
	<i>Phakellia</i> sp.	Axinellidae	
	<i>Esperiopsis villosa</i> (ZEW)	Esperiopsidae	
	<i>Geodia barretti</i>	Geodiidae	
	<i>Geodia macandrewii</i>	Geodiidae	
	<i>Geodia phlegraei</i>	Geodiidae	
	<i>Mycale (Mycale) lingua</i> (YHL)	Mycalidae	
	<i>Thenia muricata</i>		
	<i>Polymastia</i> spp. (ZPY)	Pachastrellidae	
	<i>Weberella bursa</i>	Polymastiidae	
	<i>Weberella</i> sp. (ZWB)	Polymastiidae	
	<i>Asconema foliatum</i> (ZBA)	Rossellidae	
	<i>Craniella cranium</i>	Tetillidae	
Stony corals (CSS) (known seamount species may not occur in abundance in the NRA)	<i>Lophelia pertusa</i> (LWS)	Caryophylliidae	Cnidaria
	<i>Solenosmilia variabilis</i> (RZT)	Caryophylliidae	
	<i>Enallopsammia rostrata</i> (FEY)	Dendrophylliidae	
	<i>Madrepora oculata</i> (MVI)	Oculinidae	
Small gorgonian corals (GGW)	<i>Anthothela grandiflora</i> (WAG)	Anthothelidae	Cnidaria
	<i>Chrysogorgia</i> sp. (FHX)	Chrysogorgiidae	
	<i>Radicipes gracilis</i> (CZN)	Chrysogorgiidae	
	<i>Metallogorgia melanotrichos</i>	Chrysogorgiidae	
	<i>Acanella arbuscula</i>	Isididae	
	<i>Acanella eburnea</i>	Isididae	
	<i>Swiftia</i> sp.	Plexauridae	
Large gorgonian corals (GGW)	<i>Narella laxa</i>	Primnoidae	Cnidaria
	<i>Acanthogorgia armata</i> (AZC)	Acanthogorgiidae	
	<i>Iridogorgia</i> sp.	Chrysogorgiidae	
	<i>Corallium bathyrrubrum</i>	Coralliidae	
	<i>Corallium bayeri</i>	Coralliidae	

	<i>Keratoisis ornata</i> (KRY)	Isididae	
	<i>Keratoisis</i> sp.	Isididae	
	<i>Lepidisis</i> spp. (QFX)	Isididae	
	<i>Paragorgia arborea</i> (BFU)	Paragorgiidae	
	<i>Paragorgia johnsoni</i> (BFV)	Paragorgiidae	
	<i>Paramuricea grandis</i>	Plexauridae	
	<i>Paramuricea placomus</i>	Plexauridae	
	<i>Paramuricea</i> spp. (PZL)	Plexauridae	
	<i>Placogorgia</i> sp.	Plexauridae	
	<i>Placogorgia terceira</i>	Plexauridae	
	<i>Calyptrophora</i> sp.	Primnoidae	
	<i>Parastenella atlantica</i>	Primnoidae	
	<i>Primnoa resedaeformis</i>		
	(QOE)	Primnoidae	
	<i>Thouarella grasshoffi</i>	Primnoidae	
Sea pens (NTW)	<i>Anthoptilum grandiflorum</i>	Anthoptilidae	Cnidaria
	<i>Funiculina quadrangularis</i>		
	(FQI)	Funiculinidae	
	<i>Halipteris</i> cf. <i>christii</i>	Halipteridae	
	<i>Halipteris finmarchica</i> (HFM)	Halipteridae	
	<i>Halipteris</i> spp. (ZHX)	Halipteridae	
	<i>Kophobelemnnon stelliferum</i>		
	(KVF)	Kophobelemnidae	
	<i>Pennatula aculeata</i> (QAC)	Pennatulidae	
	<i>Pennatula grandis</i>	Pennatulidae	
	<i>Pennatula</i> sp.	Pennatulidae	
	<i>Distichoptilum gracile</i> (WDG)	Protoptilidae	
	<i>Protoptilum</i> sp.	Protoptilidae	
	<i>Umbellula lindahli</i>	Umbellulidae	
	<i>Virgularia</i> cf. <i>mirabilis</i>	Virgulariidae	
Tube-dwelling anemones	<i>Pachycerianthus borealis</i>	Cerianthidae	Cnidaria
	(WQB)		
Erect bryozoans (BZN)	<i>Eucratea loricata</i> (WEL)	Eucrateidae	Bryozoa
Sea lilies (Crinoids) (CWD)	<i>Trichometra cubensis</i>	Antedonidae	Echinoder
	<i>Conocrinus lofotensis</i> (WCF)	Bourgueticrinidae	mata
	<i>Gephyrocrinus grimaldii</i>	Hyocrinidae	
Sea squirts (SSX)	<i>Boltenia ovifera</i> (WBO)	Pyuridae	Chordata
	<i>Halocynthia aurantium</i>	Pyuridae	