Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2014/032

Newfoundland and Labrador Region

Proceedings of the Regional Peer Review on Monitoring Indicators, Protocols and Strategies for the Proposed Laurentian Channel Marine Protected Area (MPA)

June 24-26, 2014
St. John's, Newfoundland

Chairperson: Robin Anderson
Editors: Sara Lewis, Viviana Ramírez-Luna and Nadine Templeman

Science Branch
Fisheries and Oceans Canada
PO Box 5667
St. John's, NL A1C 5X1

December 2015

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1701-1280

Correct citation for this publication:

DFO. 2015. Proceedings of the Regional Peer Review on Monitoring Indicators, Protocols and Strategies for the Proposed Laurentian Channel Marine Protected Area (MPA); June 24-26, 2014. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2014/032.

TABLE OF CONTENTS

SUMMARY

A Canadian Science Advisory Secretariat (CSAS) Regional Science Peer Review Process was held June 24-26, 2014 in St. John's, Newfoundland and Labrador (NL) to provide a scientific peer review of a proposed Laurentian Channel Marine Protected Area (LC MPA) monitoring framework.

This meeting was held in response to a request from Fisheries and Oceans Canada (DFO) Oceans sector which asked DFO Science sector to provide support and advice on the proposed LC MPA. Participation at the meeting included DFO Science, DFO Ecosystems Management (NL and Maritimes (MAR) Regions), and Memorial University of Newfoundland/Marine Institute.

Three categories of indicators are proposed for monitoring the LC MPA:

1. direct indicators, which provide information on status and trends of species of interest related to the Conservation Objectives (COs);
2. indirect indicators, which will provide information on biotic and abiotic components of the environment that can help account for changes in the COs; and
3. anthropogenic pressure indicators, which can assess human activities that may affect the COs inside and outside of (i.e., adjacent to) the LC MPA.

Overall, 14 direct indicators, 24 indirect indicators and 13 anthropogenic indicators have been identified to monitor the LC MPA (Appendix I). Analysis of the status and trends of these indicators will provide MPA managers with the necessary information to assess effects resulting from establishment of the LC MPA. They will also allow assessment of the direct effects of management measures enacted through establishing this MPA, in context of the overall variation or changes within the ecosystem. Assessment of effects of the MPA on the Conservation Objectives (COs) requires appropriate selection and use of control/reference areas; to be determined in conjunction with a Scientific Steering Committee. These areas, outside of the MPA, should be selected to represent habitat, species, assemblages and conditions similar to the treatment area (i.e. inside the MPA), and to evaluate the abilities of monitoring protocols and strategies to detect changes between these areas as compared to natural variability within the MPA. Hypothesis-driven assessments of MPAs provide scientific defensibility for any monitoring program.

Recommendations related to additional considerations for adding or removing indicators, protocols or strategies and/or providing advice on this topic in the future were also put forward.

Compte rendu de l'examen régional par les pairs des indicateurs, protocoles et stratégies de surveillance de la zone de protection marine proposée pour le chenal Laurentien

SOMMAIRE

Un processus régional d'examen scientifique par les pairs du Secrétariat canadien de consultation scientifique (SCCS) a eu lieu du 24 au 26 juin 2014 à St. John's (Terre-Neuve-et-Labrador) afin de fournir un examen scientifique par les pairs d'un cadre de surveillance de la zone de protection marine (ZPM) proposée pour le chenal Laurentien.

Cette réunion a été tenue en réponse à une demande du Secteur des océans de Pêches et Océans Canada (MPO), qui a demandé au Secteur des sciences du MPO de fournir un soutien et des conseils à l'égard de la ZPM proposée pour le chenal Laurentien. Parmi les participants à la réunion, on comptait des représentants du Secteur des sciences du MPO, de la Direction de la gestion des écosystèmes du MPO (régions de Terre-Neuve-et-Labrador et des Maritimes) et de l'Université Memorial de Terre-Neuve (Marine Institute).

Trois catégories d'indicateurs sont proposées pour la surveillance de la ZPM du chenal Laurentien :

1. Les indicateurs directs, qui fournissent des renseignements sur l'état et les tendances des espèces d'intérêt relativement aux objectifs de conservation;
2. Les indicateurs indirects, qui fournissent des renseignements sur les composantes biotiques et abiotiques de l'environnement qui peuvent aider à expliquer les changements dans les objectifs de conservation;
3. Les indicateurs des pressions découlant des activités anthropiques, qui permettent d'évaluer les activités humaines à l'intérieur et à l'extérieur (c.-à-d. à proximité) de la ZPM du chenal Laurentien qui pourraient avoir une incidence sur les objectifs de conservation.

On a déterminé au total 14 indicateurs directs, 24 indicateurs indirects et 13 indicateurs anthropiques pour surveiller la ZPM du chenal Laurentien (annexe I). L'analyse de l'état et des tendances de ces indicateurs fournira aux gestionnaires de la ZPM les renseignements nécessaires pour évaluer les effets découlant de l'établissement de la ZPM du chenal Laurentien. Elle permettra également d'évaluer les effets directs des mesures de gestion adoptées par le biais de l'établissement de la ZPM, dans le contexte de l'ensemble de la variation ou des changements au sein de l'écosystème. L'évaluation des effets de la ZPM sur les objectifs de conservation exige le choix et l'utilisation appropriés des zones de référence ou de contrôle; ces zones doivent être déterminées en collaboration avec un comité directeur scientifique. Ces zones, situées en dehors de la ZPM, devraient être choisies pour être représentatives de l'habitat, des espèces, des communautés et des conditions similaires à celles de la zone de traitement (c.-à-d. à l'intérieur de la ZPM) et pour évaluer les capacités des protocoles et des stratégies de surveillance à détecter les changements entre ces zones par rapport à la variabilité naturelle au sein de la ZPM. Les évaluations des ZPM qui s'appuient sur des hypothèses offrent une validité scientifique à tout programme de surveillance.

On présente aussi des recommandations sur les autres facteurs à prendre en compte à l'avenir pour l'ajout ou le retrait d'indicateurs, de protocoles ou de stratégies ainsi que la prestation de conseils à ce sujet.

INTRODUCTION

In support of the Health of the Oceans Initiative, Fisheries and Oceans Canada's (DFO) Science sector is required to provide advice on indicators, protocols and strategies for monitoring of conservation objectives for Marine Protected Areas (MPAs).

An Area of Interest (AOI), the proposed Laurentian Channel Marine Protected Area (LC MPA), is located off of the southwest coast of Newfoundland and Labrador and covers approximately 11,908 km^2 (Fig. 1). Upon designation, it will be the largest "no-take fisheries area" in Canada to date. The overarching goal of the MPA will be to "conserve biodiversity in the LC MPA through protection of key species and habitats, ecosystem structure and function and scientific research". There are also a set of six primary Conservation Objectives (COs) proposed to represent a range of species within the LC MPA. Further, six research objectives have been identified that will serve to advance the understanding of various ecosystem components that have been identified as important to the LC MPA and require further investigation.

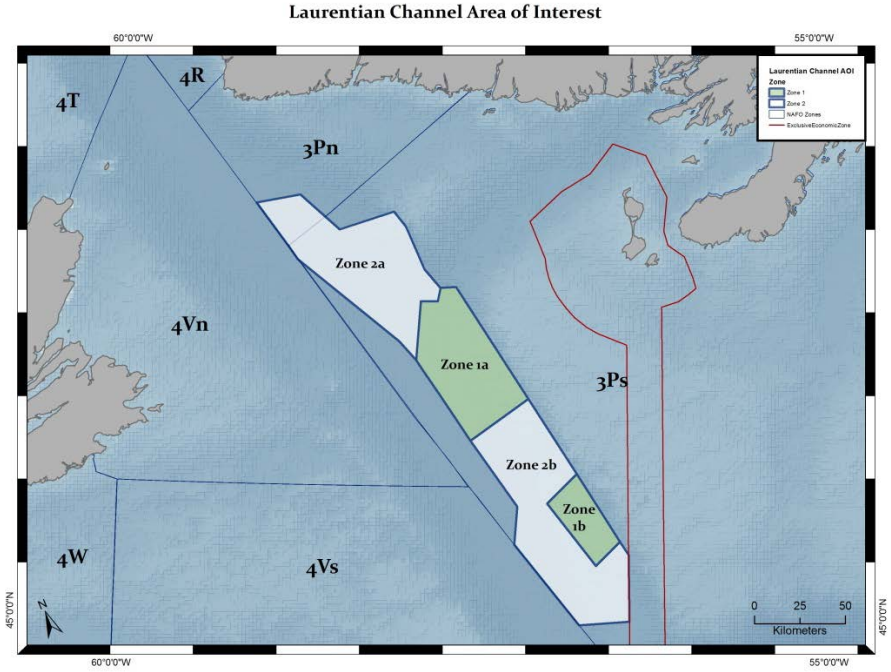

Figure 1. Map of the proposed Laurentian Channel Marine Protected Area (LC MPA), Newfoundland and Labrador Region.

This Proceedings report summarizes the relevant discussions and presents the key conclusions reached during the June 24-26, 2014 meeting based on one working paper (Lewis et al., *in press*) focused on the Monitoring Indicators, Protocols and Strategies for the Proposed LC MPA. In addition, a Science Advisory Report and Research Document resulting from the meeting will be published on the DFO Canadian Science Advisory Secretariat (CSAS) Website.

PRESENTATIONS

CONTEXT FOR REQUEST FOR SCIENCE ADVICE AND TERMS OF REFERENCE: SCIENCE SUPPORT FOR THE DEVELOPMENT OF THE LAURENTIAN CHANNEL MPA

Presenter: Nadine Templeman

Abstract

The terms of reference (TOR) was reviewed (Appendix I). An introduction to the LC MPA was presented including a history of the different types of science advice that has been used in the development of the LC AOI and proposed LC MPA. The context for the current meeting was discussed to ensure participants had a common understanding of the scope of the meeting.

Discussion

A discussion occurred regarding the boundary selection process of the proposed LC MPA and whether the MPA was “leftover” from commercial fisheries in the area. Recent fishing pressure in the proposed area is very small according to the charts of distribution of gear activity shown during the presentation. The presenter explained that the boundaries resulted from multiple processes including the Ecologically and Biologically Significant Areas (EBSA) process, consultation with stakeholders, as well as socio-economic considerations. The presenter also clarified that the calculation of percentages per species occurrence inside-outside the MPA were derived in relation to the Northwest Atlantic Fisheries Organization (NAFO) Div. 3P.

APPROACH TO MONITORING FRAMEWORK: A FRAMEWORK FOR THE IDENTIFICATION OF MONITORING INDICATORS, PROTOCOLS AND STRATEGIES FOR THE LAURENTIAN CHANNEL MPA

Presenter: Sara Lewis

Abstract

The strategy for addressing the Terms of Reference (TOR) was discussed. The indicators were divided into three categories:

1. direct;
2. indirect; and
3. anthropogenic stressor indicators.

The direct indicators will inform changes in the COs based on monitoring the status and trends of species of interest. The indirect indicators, such as oceanographic and ecosystem parameters, are proposed to help inform changes in the COs such as environmental conditions and habitat considerations which are essential for understanding the causes of change that are not impacted by the MPA. Finally, the anthropogenic stressor indicators can have direct consequences to COs and should be monitored accordingly. Current and potential monitoring protocols and strategies for monitoring the indicators were identified as well as the difference between protocols and strategies. A Scientific Steering Committee was proposed that would be responsible for providing advice on the ongoing monitoring plan, results and potential research initiatives associated with the LC MPA.

Discussion

There was a discussion regarding the membership of the Steering Committee proposed by the presenter. Participants wanted to ensure that industry and other external members could be part

of the committee given that some members may have specific scientific backgrounds but may lack experience in MPA design, objectives, etc. which others can provide. Participants also suggested that the industry should be involved in the MPA data collection. The presenter explained that the suggestion for Steering Committee membership was intended to have participation along all areas of science and management expertise from DFO and working groups could be established with external participation that would be able to focus on advancing the various components given the diversity of the COs and potential indicators.

SPECIES OF INTEREST OVERVIEW - CORALS (SEA PENS): SPECIES SUMMARY

Presenter: Kent Gilkinson

Abstract

The LC supports the highest recorded concentrations of sea pens in eastern Canada. Where sea pens are concentrated (i.e. high densities), they are classified as Vulnerable Marine Ecosystem (VME) component species. Sea pen trawl bycatch records from DFO multispecies bottom trawl research surveys (n=238 sets) covering the 2004-12 time period, within and adjacent to the LC, were analyzed in terms of geographic patterns of trawl catch species occurrence and richness (i.e. number of species) and biomass. Sea pens occur throughout the entire LC MPA and frequency of occurrence of sea pens in trawl tows was moderately high, ranging from 55-67% within the four MPA zones. A total of five sea pen species have been recorded while greater than one third of the records are unidentified, listed only as 'sea pen', i.e. *Pennatulacea*. Highest sea pen species richness per trawl tow occurred in Zones 1b and 2b to the south. Using a trawl bycatch threshold of 0.4 kg used to distinguish locations of sea pen concentrations from lower background levels, highest biomass records occurred in Zone 1a, including a 40 kg record. Geographic patterns of occurrence and species richness of other coral taxa and sponge biomass records were also assessed.

Discussion

There were questions regarding sea pen growth rate, size and longevity ranges, fragility, predators, and how these parameters influence the ability of researchers to detect changes in their populations over time (e.g. recruitment events). Attendees pointed out that based on studies from the North Pacific and depending on the species, sea pen growth rates can range between 1.5-5.0 cm/year (linear extension) and they can reach heights of 30 cm to 2 m or higher; they can live between 15 and 40 years; and can be prey for nudibranchs including sea stars as well as fishes. It was also noted that, depending on the equipment used (e.g. the remotely operated vehicle ROPOS), organisms down to millimeters can be detected if surveying close enough to the bottom.

There was an inquiry about the designation of Zone 1b of the LC MPA, given that higher richness seems to be surrounding this zone. It was noted that these zones are structured based on negotiations and the best information available, and as new information becomes available (not only on corals but on other species as well), it will be used to improve management measures following an adaptive management approach.

SPECIES OF INTEREST OVERVIEW - BLACK DOGFISH: SPECIES SUMMARY

Presenter: Mark Simpson

Abstract

Black Dogfish are widely distributed in the northwest Atlantic from south Baffin Island and Greenland to Virginia (USA). Current knowledge of its life history characteristics were

summarized and abundance and distribution maps (DFO-NL research surveys; DFO-MAR research surveys; European Union (EU)-Spain surveys) were presented. Although no directed fishery exists in Canadian and adjacent international waters, ongoing bycatch of this species do occur primarily in Greenland Halibut, Atlantic Halibut, and redfish fisheries. Although at-sea fisheries observers are the only source of fishing mortality estimates, low or non-existent observer coverage of these bycatch fisheries was also noted. Ongoing DFO multispecies research surveys monitor abundance and biomass of this species though the surveys do not cover the entire depth range of this species. Existing survey data indicate that there is size segregation in the distribution of this species.

Discussion

Participants discussed data gaps including the truncated length distribution data for Black Dogfish, thus it has not been possible to conduct growth-maturity studies. Large animals (85 cm and above) are necessary for these studies but are not being caught. It is not known whether on-off-slope movements occur; therefore, strata by strata comparisons are needed. Even though commercial fisheries will be restricted inside the LC MPA, it is important to continue collecting catch data outside the LC MPA in order to identify fishing mortality in the entire area. Further, given data availability, the distribution of Black Dogfish along the two strata adjacent to the LC MPA in the MAR Region is not well understood. There are plans to start systematic monitoring this area in summer 2014 by the MAR Region which will be useful in this regard.

SPECIES OF INTEREST OVERVIEW - SMOOTH SKATE: SPECIES SUMMARY

Presenter: Mark Simpson

Abstract

Smooth Skates are distributed off of Newfoundland and the southern Gulf of St. Lawrence to New Jersey (USA). Current knowledge of its life history characteristics was summarized and abundance and distribution maps (DFO-NL research surveys; DFO-MAR research surveys; US-Northeast Fisheries Science Center (NEFSC) surveys) were presented. Although no directed fishery exists in Canadian and adjacent international waters, ongoing bycatch of this species do occur primarily in Greenland Halibut, Atlantic Cod, redfish, and shrimp fisheries. Although at-sea fisheries observers are the only source of fishing mortality estimates, low or non-existent observer coverage of these bycatch fisheries was also noted. Ongoing DFO multispecies research surveys monitor abundance and biomass of this species. Young of the year (YOY) Smooth Skate are found both inside and outside of the proposed MPA area.

Discussion

Data gaps associated with Smooth Skate were identified and discussed. Comparisons between inside and outside the LC MPA (within NAFO Subdiv. 3Ps) show no difference in the distribution of YOY (around 11 cm), or immature (around 47 cm) individuals. Therefore, it is not certain how this lack of separation between life stages inside and outside the LC MPA will influence monitoring the CO which focuses on immature Smooth Skate. Data exists from stomach contents for all 12 skate species, but is not yet analysed or published. Niche separation between these 12 species is being examined in order to determine how these species co-exist given the large spectrum of sizes. Since 2000, observer data for Smooth Skate has been very reliable due to training initiatives (identification practices, material, and testing of individuals) and consistency between observers. Prior to initiation of training, the identification of Smooth Skate by observers was questionable; therefore, historic data must be analysed carefully. Notably, there is a huge jump in Smooth Skate sightings in the 2012 observer data which seems to be related to improvement in identification rather than changes in abundance.

SPECIES OF INTEREST OVERVIEW - NORTHERN WOLFFISH: SPECIES SUMMARY

Presenter: Mark Simpson

Abstract

Northern Wolffish is widely distributed in the northwest Atlantic and near the southern extent of its distribution in the proposed LC MPA. Current knowledge of its life history characteristics was summarized and abundance and distribution maps (DFO-NL research surveys; DFO-MAR research surveys) were presented. Although no directed fishery exists in Canadian and adjacent international waters, ongoing bycatch of this species does occur in groundfish and shrimp trawl fisheries. Given that at-sea fisheries observers are the only source of fishing mortality estimates, observer coverage of these bycatch fisheries was considered incomplete. Ongoing DFO multispecies research surveys monitor abundance and biomass of this species.

Discussion

Participants discussed habitat preferences of the Northern Wolffish in terms of data gaps and the requirements of the species. A study on habitat association and distribution of the three species of wolffish found that there is no preference for any specific substrate. The lack of habitat preference for wolffish is important, as it has been a general assumption that wolffish are found in rocky habitats only. Ground-truthing shows there is mud in the LC, but also gravel/cobble areas. This could mean there is some diversity of substrate for wolffish. However, they might be using different substrates depending on their behaviour. It was noted that the wolffish population is likely underestimated within DFO spring and fall surveys which could be due to catchability which is not ideal for this species given deep water behavior of wolffish. Also, rocky areas are avoided by trawlers, which is the method employed by DFO to sample wolffish.

It is unlikely any changes in the wolffish population in the MPA will be observed in the short term given their low reproduction rate and location at the southern extent of their range. Global warming is a big issue for Northern Wolffish in the LC MPA given that this area is mostly in the southern end of wolffish distribution. There is evidence from Greenland surveys, that Northern Wolffish and the other species of wolffish distribution are moving northward.

SPECIES OF INTEREST OVERVIEW - PORBEAGLE SHARK: SPECIES SUMMARY

Presenter: Mark Simpson

Abstract

Porbeagle shark is a highly migratory species in temperate waters. Current knowledge of its life history characteristics was summarized and distribution maps (Canadian at sea observer commercial data; DFO-MAR shark survey) relative to the proposed LC MPA were presented. The historical Porbeagle-directed fishery in Canadian and adjacent international waters was also presented, while ongoing bycatch of this species occurs in Swordfish/Tuna longline and groundfish gillnet fisheries. Although at-sea fisheries observers are the only source of fishing mortality estimates, low or non-existent observer coverage of these bycatch fisheries was also noted. DFO multispecies research surveys do not catch Porbeagle sharks.

Discussion

It was noted that Porbeagle is a highly migratory species; therefore, it will be challenging to link the management measures to the greater Porbeagle population because this species normally passes through the LC. There was a paper published a number of years ago that found a

mating area in the south part of the southern Grand Banks – this is not in the LC MPA specifically.

SPECIES OF INTEREST OVERVIEW - LEATHERBACK SEA TURTLE: SPECIES SUMMARY

Presenter: Jack Lawson

Abstract

Leatherback sea turtles are the most frequently occurring sea turtle in area 3P off the Newfoundland south coast. The largest concentrations occur on the continental shelf and slope off the Newfoundland south coast; but also further offshore. Based on sighting records collected since 1946 and more recent survey research, we know they return to this area each summer (particularly August and September) following an annual migration from breeding areas at low latitudes (South and Central America, the Caribbean, and continental U.S.). Based on satellite tracking and aerial survey studies, the Scotian Shelf and Newfoundland south coast are important foraging habitat in temperate waters where these turtles aggregate to consume jellyfish. Leatherbacks are specialist predators on jellyfish, and each turtle may have to consume almost 100 lion's mane jellyfish per day while they are in these waters. Evidence suggests that the LC MPA represents a migration pathway for the leatherback between these feeding areas. Low abundance and a variety of anthropogenic threats have contributed to DFO's decision to list leatherback turtles as 'endangered' under the *Species at Risk Act* (SARA). Behavioural responses to noise such as seismic surveys, which have taken place in the LC MPA study area, have been observed in leatherback turtles. By focusing research efforts, the establishment of the LC MPA could contribute to the mitigation of the other main threats associated with fixed fishing gear and vessel strikes. Information gaps associated with the leatherback turtles in the LC MPA include:

1. precise information about population size and trends in these waters;
2. frequency of incidental capture by fixed gears, mortality, and post-release survivorship;
3. contribution of vessel strikes to injury and mortality;
4. contribution of marine pollution (debris and contaminants) to injury and mortality; and
5. better understanding of negative effect of noise on leatherback behaviour.

Discussion

Participants discussed the use of proxies for Leatherback Turtles given the lack of significant effort and sightings in the LC region. Sunfish could be used as a proxy for turtles as the National Oceanic and Atmospheric Administration (NOAA) is doing in the northeast USA. Based on a ratio of the number of sunfish and leatherback sightings during DFO surveys (i.e. Sunfish is usually higher), it may be possible to have a correction factor for sighted animals in the future. There are relatively limited tow data for jellyfish abundance to establish a proxy for jellyfish but linkages can be improved with directed effort and research.

A general additive model (GAM) was used to determine populations based on the Trans North Atlantic Sightings Survey (TNASS) data which is still being updated; however, the predictive power is quite good. Temperature and bathymetry as model variables have determined that more jellyfish and turtles are seen in shallow waters. However, there is less effort in deeper water, so less is known about the jellyfish in those waters. Based on satellite tags, it seems that LC is a migration path rather than a feeding ground for Leatherbacks. Leatherbacks are completely aquatic animals; they never come to shore unless they are very sick. Once they hatch, males never come ashore, except to die; females do a few times to lay eggs.

LAURENTIAN CHANNEL MULTIBEAM SURVEY UPDATE

Presenter: Sigrid Kuehnemund

Abstract

The presentation provided an update on the findings of the multibeam surveys (bathymetry, backscatter, sub-bottom profile sound velocity data and associated imagery) conducted within the LC from 2011 to 2014, which will contribute to the body of knowledge required for MPA evaluation, designation and management. Information was provided on the geologic analysis (including preliminary substrate characterization), glacial processes affecting the area and occurrence of iceberg scour and pockmarks. Additional biological and geological interpretation is required before developing a benthic habitat map for the area.

Discussion

This presentation was added to the agenda in order to provide information on methods other than DFO trawl surveys that have been used to study benthic habitats within the LC MPA. The importance of this data for the monitoring program was highlighted. Some concerns were raised regarding the analysis of the backscatter data (i.e., if the data comes from different platforms, data cannot be integrated in a single analysis); and the sampling grid size, which is important to know for determination of distinguishable size features. The presenter stated that researchers are currently focusing on collecting, analyzing, interpreting and using new data as it becomes available, following the Adaptive Management approach.

Another discussion centered on finding equivalent data rich areas adjacent to the LC MPA that can be used as reference areas. It was noted that there are some areas that were surveyed using multibeam that currently are not part of the LC MPA. The presenter added that there are no plans to extend the sampling to other areas because it is logistically challenging and expensive but areas like St. Anns Bank have also been surveyed as part of a MAR Region initiative to designate a St. Anns Bank AOI. Additionally, there are available databases such as the Geological Survey of Canada that could be investigated.

DIRECT INDICATORS

Presenter: Sara Lewis

Abstract

A series of direct indicators were presented that coincide with the species of interest. Direct indicators are based on discussions with the various DFO Science representatives for each species and literature reviews as noted in the working paper. Some indicators will be easily achievable in existing programmes while others require further research and planning with the species or subject area experts.

Discussion

The general challenges to identify the appropriate indicators were discussed including: occurrence of rare species (e.g. wolffish, for which only a few occurrence observations exist), mobility of species through the LC boundaries (not only highly migratory such as the Leatherback Sea Turtle but also local species such as Black Dogfish and Smooth Skate), lack of understanding of what needs to be measured (including costs of logistics), lack of accurate life history data within the MPA (e.g. proof of reproduction of Porbeagle in the LC MPA), and lack of hypothesis. Other challenges identified include the design of the MPA itself because it can only control human activities not the survival and reproduction of species; recognition that fishing levels inside the current boundaries are very low; therefore, little change in species

response can be expected inside the MPA due to human activity restrictions; and requirements for clear indicators in such a wide range of species.

Participants were concerned with the wording of the COs because of the potential for misinterpretation of the MPA goals, i.e. it will contribute to species reproduction and survival while in reality, the MPA is designed to regulate human activities and their consequences (species mortality) not species *per se.* Some participants argued that the MPA should look beyond the six COs to incorporate an Ecosystem Approach to reflect biodiversity and the LC as an ecosystem instead of six select species. The term "biodiversity" (included in the overarching goal of the MPA) must be defined, and it is suggested to use "species diversity and richness" or "taxonomic diversity" (recognizing that diversity can occur at different levels: families, orders, species, etc.). Oceans staff highlighted that the MPA is expected to restrict human activities only and that the COs are the result of science advice in the past (identification of EBSAs and list of COs for each EBSA). It is important to determine whether all indicators should be weighed equally as some indicators can be more important or influential compared to others given the differences between species. Also, consideration should be given to which indicators can be measured (this is a **list of potential indicators** and many factors such as logistics need to be taken into account) and how variability can be minimized.

Participants suggested hypotheses to ensure scientists and managers can understand what to measure as well as to predict the outcomes (inside-outside) (Table 1). In order to determine if the MPA is functioning as intended, the hypotheses and indicators must be measured inside and outside the MPA using identical methods. The inside-outside (control area) approach is also necessary given the low level of human activity inside the MPA. For instance, it would be expected that outside the MPA where fishing activity occurs, population size and density would decrease, while within the MPA, it is expected to find lack of change as opposed to continuing deterioration.

It is recommended to use the terms "being maintained or increased relative to outside areas" when referring to indicator performance and the overarching goal. This recommendation was linked to the debate on the low frequency of fishing within the current boundaries of the MPA and therefore the current status of COs would be maintained i.e. significant changes would not be expected. Also, the use of "relative to outside areas" highlights the fact that comparisons are relative and are made according to reference areas. There was discussion regarding the term "pristine", given that there have been fisheries inside the MPA in the past (there was a large bottom trawl redfish fishery in the 1980s).

It is important to anticipate lag time to gauge a response, which depends on species' life span, age of maturity, and detectability as well as the protocols used. For instance, corals can take up to 10 years before detection, while the age of maturity may be more important for some other species. Also, it must be understood that "time zero" is the time the pressure stopped (e.g. fishing, around 15 years ago) rather than when the MPA is established. For the fish species of interest, lag time to be used should be estimated following the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) definition (i.e. three generation times) because it provides a biological basis for the metric. However, the definition of lag time for all the species of interest remains as a data gap. The concept of statistical power was introduced and should be considered further for all species.

Sea Pen Direct Indicators Discussion

When considering changes in size distribution, it is necessary to allow for recruitment which is a big gap in deep sea coral biology. Another issue regarding the measurement of diversity involves gaps in taxonomy, especially of sea pens, as many are not identified. It is also

suggested to consider local diversity as opposed to diversity in the entire MPA, however, quantifying diversity is difficult given the gaps in sea pen taxonomy. It is suggested that there could be changes in patterns of existing species rather than finding new species. Species richness can also seem to increase as a result of increased sampling or research effort.

Further consideration should be given to climate change. Increased freshwater coming through the Gulf could potentially impact coral patch distributions and sizes. It was noted that local sea pen species are less sensitive to ocean acidification; fishing is a greater concern when detecting changes in populations.

Black Dogfish Direct Indicators Discussion

There was a recommendation to modify CO wording (see Appendix IV). Some movement patterns identified for Black Dogfish suggest that the LC could potentially be a source for populations outside Subdiv. 3Ps and the LC, i.e. pups occur in 3Ps and the LC MPA while adults move to deeper waters in Div. 3LMN making them vulnerable to fishing outside the MPA. Consequently, it can be challenging to compare biomass and size distribution of this species inside and outside the MPA. It is important to monitor both sides of the MPA using the same catch metrics to measure the impact of bycatch and the impact on the MPA performance. Lag time for Black Dogfish was estimated to be 32 years.

Smooth Skate Direct Indicators Discussion

There is a recommendation to modify CO wording (See Appendix IV). The CO wording includes “stock”, which is problematic because there is no definition of “stock” and no biological reasons to separate into stocks. Regarding a reference area, the Hermitage Channel could be used. It is necessary to push for better identification of skate species in fisheries so changes comparing inside-outside can be measured. Lag time for Smooth Skate is estimated to be 48 years.

Porbeagle Direct Indicators Discussion

There is a recommendation to modify CO wording (See Appendix IV). Formulating a hypothesis for Porbeagle is challenging because it cannot be expected that abundance, size distribution, mean lifespan, occurrence, or distribution will increase as a result of the MPA designation. Occurrence was moved to indirect indicators because it does not have a specific hypothesis but can be easily monitored. Lag time for Porbeagle is approximately 54 years.

The lack of observers and lack of reporting requirements for bycatch is problematic when comparing outside-inside indicators. Bycatch is an unknown source of mortality. Extending observer coverage can be challenging because it is industry-funded. In the MAR Region, Oceans (e.g. through SARA) has paid for more observer coverage via contracts.

Northern Wolffish Direct Indicators Discussion

There are no recommendations to modify CO wording, as it follows SARA phraseology. It can be challenging to detect any changes in wolffish population given its sparse distribution in the area, which is also related to the number of zero sets in the trawl data. Similar to the Porbeagle, occurrence was moved to indirect indicators because it does not have a specific hypothesis but can be easily monitored. Lag time for Northern Wolffish is estimated to be three generation times.

Leatherback Sea Turtle Direct Indicators Discussion

There is no recommendation to modify CO wording for Leatherback Turtles, as it follows SARA wording. Similar to the Porbeagle shark, formulating a hypothesis was found to be challenging because it cannot be expected that turtle attributes will increase as a result of MPA establishment. The main effect should be the reduction of lethal encounters. It is suggested to use “lethal encounters with fishing gear or vessels” and “immediately non-lethal entanglements” as indicators. The latter indicates that animals might die after they are released, which makes it necessary to conduct post-encounter mortality studies. Change can be measured as the number of injuries or mortalities inside the MPA. Detecting change in abundance and distribution can be problematic given the low numbers and sparse distribution. Additionally, although there is an abundance estimate for the south coast, it cannot be divided into inside and outside the MPA. It may be more meaningful to consider the entire region. As with Porbeagle, occurrence was moved to indirect indicators because it does not have a specific hypothesis but can be easily monitored. Lag time for Leatherback Sea Turtle is unknown. Mortality due to entanglement can be distinguished (i.e. entanglements are reported by fishers) while ship strikes might have occurred somewhere along the south coast, when corpses wash ashore. It is noted that marine traffic will not be restricted inside the MPA. Therefore, changes in mortality due to vessel strikes cannot be expected. However, it is observed that the risk of getting struck by vessels is very low and may not measurable/discernible between inside/outside the MPA. The risk of vessel strikes is higher closer to shore to due higher volumes of traffic.

INDIRECT INDICATORS

Presenter: Sara Lewis

Abstract

Indirect indicators are a means to assess the environmental and habitat conditions to explain changes in the status and trends of the COs. These are deemed to be critical for gaining a better understanding of the ecosystem because nothing works in isolation. Indirect indicators were divided and discussed using categories including: environmental (oceanographic and sediment), habitat and ecosystem.

Discussion

Participants agreed it is necessary to be more specific regarding how indirect indicators provide information for the COs. Clear distinction must be made to ensure these indirect indicators are not suggested to change as a result of the establishment of the MPA. It is also important to clarify which indicators require further monitoring effort in terms of frequency (i.e. discrete or continuous sampling) and where establishment of baselines are required. Indirect indicators also must be measured outside and inside the MPA where appropriate, similar to the direct indicators.

The categorization of the indirect indicators was discussed. It is suggested to use “potential drivers of indicators” or “key ecosystem variables”. The latter is a better term as it might hold more weight, as something that needs to be undertaken. Ecosystem Indicators should be incorporated as indirect indicators and are related to community composition and structure, biomass of predator/prey, and species composition. The hypothesis (following the discussion about the overarching goal) is that the ecosystem structure and function will be maintained. Trophic interactions can be added under the category ecosystem indicators. General items to be added: measurements for habitat; the term “epifaunal” (in “Infaunal community composition”) rather than “infaunal”; gas leakage from pockmarks and the impact on benthic communities.

Some other indicators included under Environmental Indicators are:

- Labrador Current and water masses movement;
- nutrient flux between the sediment and water column (related to biodiversity on the sea floor and primary production); and
- acoustic backscatter; and seabed sediment chemistry and composition (might play a greater role on coral distribution than any other variable).

Incidence of harmful algal blooms could be excluded as it was not clear how to measure it at the MPA scale.

ANTHROPOGENIC INDICATORS

Presenter: Sara Lewis

Abstract

Although it is not within the mandate of DFO Science, it was deemed necessary to discuss the anthropogenic stressor indicators that could potentially inform changes in the species of interest. Also, the wording of the COs is such that they control human activities within the MPA. It would be essential to determine if any resulting effects outside the MPA are a consequence of the displacement of human activities. The anthropogenic stressor indicators can be useful in answering that question.

Discussion

Some indicators that could be included are:

- compliance (easy to monitor and gives an idea of human activities inside the MPA; zero mortality inside the MPA could not be assumed if violations occur);
- vessel traffic (needs to be categorized such as fisheries, transit vessels, etc., to reflect the relevance of each type of vessel);
- seismic as a separate indicator (i.e. different effects from other oil and gas activities);
- anthropogenic sound (as a proxy for ocean acidification);
- contaminants in sediment (indicator of the impact of oil and gas activities on corals and sponges); and
- biomass removed from research surveys within the MPA.

It is important to make explicit that the inside-outside MPA sampling approach includes all indicators, where applicable, unless otherwise specified. Further, there was discussion about using a before-after MPA sampling approach, especially for those human activities that will be restricted from inside the MPA post-designation. For instance, fishing effort needs to be compared before and after designation in order to measure the effort distribution outside the MPA. However, it is noted that within the current boundaries of the LC MPA fishing levels are very low.

A table was presented (collection of Tables 1 and 2) to summarize the direct, indirect, and anthropogenic indicators to determine the relevance of each Indicator. The following are the main points of discussion:

- Biomass, size distribution, and occurrence data are available for species. Occurrence cannot be measured in the same way for all species given the variance between them e.g. from rare (wolffish) and sedentary (corals) to highly migratory (Leatherback, Porbeagle) species. “Biomass trends” might be more appropriate given catchability issues. Biomass is a term of interest for the industry sector.

- There is still confusion about how the trophic level indicator relates to the COs and informs effectiveness of the MPA; whether it refers to species or populations; whether it is based on stomach contents or isotope analysis. Suggestions include that trophic level could:
    - be moved to indirect indicator (community composition);
    - be re-worded to include prey-predator relationships; or
    - changed to “biomass of key predators and prey” since getting stomach contents can be very difficult for some species.

  Related to trophic level, the community composition and structure indicator could include prey, driver species, competitors, etc.
- Mean lifespan is challenging although some aging studies or opportunities to get aging information exist for Black Dogfish, Smooth Skate, Porbeagle, Northern Wolffish, and sea pens. It is even more difficult for Leatherback Sea Turtle, given the absence of teeth and lack of knowledge on growth rates. Length could be used however, there is variation of age, maturity, and growth rates within species. For sea pens there is not a clear relationship between size and age, but axis diameter can be used.
- The patch area, field size, density, patch connectivity, and patch dispersion indicators could be unified into abundance and distribution of corals. This takes into account that the concepts applied by Kenchington (2010) for the identification of coral patches come from landscape ecology, through which it is possible to identify individual trees. This concept has a very different scale in the ocean, so it is safer to limit monitoring to abundance and distribution of corals. It is also important to keep in mind that sea pens are found more individually than in patches.

PROTOCOLS AND STRATEGIES

Presenter: Sara Lewis

Abstract

The protocols and strategies for the measurement of the proposed indicators are intrinsically linked. Existing and potential monitoring protocols and strategies are presented to determine the suitability for LC MPA monitoring given the challenges of monitoring offshore. In many cases, existing monitoring programs are ongoing in the LC MPA area by the department such as the Multispecies Surveys and the Atlantic Zonal Monitoring Program (AZMP); therefore, it is recommended that DFO Oceans integrate monitoring requirements into current ongoing protocols and strategies to minimize costs and use proven methods. However, there are other monitoring protocols and strategies that are new and would need to commence or be developed through partnerships outside DFO for completion. The different types of protocols and strategies were outlined for the direct, indirect and anthropogenic indicators.

Discussion

Participants agreed that it is necessary to identify the indicators that will be monitored seasonally, every few years or one time only, as this might depend on species occurrence or research surveys (fall, spring). Fixed oceanographic moorings are a good option to measure temperature, oxygen, and salinity but not biological information. It is suggested to include use of an Acoustic Doppler Current Meter (ADCP) for currents; however, it is cautioned that moorings should not be overloaded given the difficulty of retrieval, which could add costs and time to existing programs.

Consistency was an important theme of discussion. It is recommended that the monitoring program attempt to achieve consistency in comparing yearly results. For example, comparison

of fishing gear outside and inside the MPA can only be completed if similar methodologies are used. Also, if there have not been gillnets in the area, then gillnets could not be used to compare species catch or bycatch.

Sampling gear to monitor sediments and measure nutrient/sediment flux include box core or multicore (better option), which can be retrieved immediately after collecting samples. A benthic tray can be left on the sea floor and retrieved or monitored using remotely operated vehicles (ROVs) or cameras. The Roxanne system is already in place and ground-truthed so this information can be used to characterize habitat; however, data processing can be challenging but possible if needed.

It was noted that landings or logbooks (national or international) are not a complete data source for use in the LC MPA because there are no discard data included in the records; therefore, they would not include the non-commercial LC species. The only source of discard data is the at-sea fisheries observers program. Enhancement of the observers program as a protocol to evaluate discard and bycatch data would be recommended.

Participants discussed the use of local ecological knowledge (LEK) as an effective protocol for collection of historical data. It would be very useful to collect the knowledge of local fishers from the LC MPA - historical records that Research Vessel (RV) surveys cannot collect given that fishers have been in the area much longer than the surveys.

Some protocols for various indicators that can be added as suggested by participants:

- The Marine Atlantic ferry from Placentia to North Sydney crosses two times a day (day and night) could be used as a platform for observers during seasonal operations to evaluate cetaceans and turtles occurrence, and maybe jellyfish aggregations;
- The use of pelagic baited camera stations to evaluate shark occurrence and seasonality was proposed (as an indicator of the health of the species not as an indicator of the impact of the MPA on sharks). Further, bottom baited cameras stations could be used to evaluate fish species habitat occupancy;
- Acoustic backscatter data from the multispecies spring trawl survey EK 60 (data has been collected continuously, there is good coverage in 3Ps); and
- Turtle bycatch information gathered from the Marine Stewardship Council (MSC) could be used as a source.

EXPERIMENTAL DESIGN

Presenter: Sara Lewis

Abstract

A scientifically defensible design of the monitoring program is essential to ensure that it can be effectively used to indicate any potential changes in the COs resulting from management action, i.e. creation of the MPA. Various topics were discussed including baseline monitoring, repeatability in protocols (e.g., vessels), statistical power, requirements for control/reference areas, etc.

Discussion

Participants discussed the various ongoing methods of monitoring protocols currently in the LC and their particular strengths and weaknesses. Caution is required when considering repeated trawling, since it might create bias thereby potentially affecting the results. Trawling will also impact corals and other species; therefore, encounter protocols must be reinforced, especially in

Zones 1a/b. Finally, the use of trawling also introduces the “catchability” issue, i.e. small individuals are not easily caught or can withdraw into the sediment.

Cameras could be used in fixed stations so it is possible to observe changes at exact points without disturbing the species and habitat. It is concluded that for bottom communities, fixed stations are important while randomized sampling is important for mobile species and for the overall statistical comparability of surveys.

There was a discussion related to “time zero”, i.e. when the pressure stopped (e.g. fishing) rather than when the MPA is established as a baseline starting point. Logbooks can also provide before-MPA data however, some fish species of interest are grouped: “skates”, “sharks”, “wolffish” or “catfish”, making it difficult to use. Baseline data is critical in understanding the changes resulting from management measures. The implementation of an education program to enable industry to assist in data collection was suggested. In St. Anns Bank, where observer coverage is not feasible, fishers are being engaged to collect observer data instead.

Reference Areas

The group discussed potential reference areas at length and determined that the LC has distinct areas and the requirements for each species of interest are distinctive as well. Historical data becomes very important when choosing reference areas. Multispecies surveys should be used given the longevity of the data source and the reference areas should come from the NL side of the LC due to the lack of data comparability of the Maritimes side of the LC. A reference area for deep water could include the area on the NL side of the LC, not part of the MPA. Comparable data are available in that area that are present for the rest of Subdiv. 3Ps. However, it is warned that adjacency does not necessarily mean similarity between areas. Suggested reference areas based on the DFO-NL multispecies stratum: 319 and 711 (based on similarities; although 319 is the slope), the outside portion of 706, outside 713, north and south of 714, the south east of the LC extending into the French zone (collaboration is possible), 715, 716 and 310 (Burgeo Bank). For turtles, an estimated area could be towards the easterly end of the LC, St. Pierre and Burin “Turtle box”, 314 if looking for density of prey, 308 for sound surveys. With respect to Black Dogfish and wolffish, areas 712-714 towards St. Pierre may be suitable.

A zonal approach should be considered given the migratory nature of shark and turtle species which could be conducted under a contract. It is noted that the choice of the reference area is important for the definition of strategies for data collection (education program, electronic logbooks, etc.). If it is expected to measure spillover effects to adjacent areas, the distance from the boundary must be considered as a variable. Ideally, monitoring of sediments, epifaunal, and infaunal organisms should be conducted yearly or even seasonally.

For comparison purposes, reference areas should include “highly trawled areas” with Zone 1a and 1b would be “no-trawl areas”. It is important to keep in mind that trawling is not the only stressor influencing the abundance of sea pens. A gradient could be considered going from inside the MPA to outside and heavily fished areas. It is warned that the conclusions regarding reference areas for corals should not be drawn only from the study by Kenchington et al. (2010) on coral density areas since it is based on a few sets and further decisions should follow results from the ongoing ground-truthing surveys.

RESEARCH OBJECTIVES

Presenter: Sara Lewis

Abstract

The Research Objectives (ROs) were discussed to ascertain from the group what questions require attention in designing a research program. Previously identified data gaps from Oceans were presented, with the expectation that others would be added by the group.

Discussion

The following additional points were raised:

- RO 1: Advance the understanding of the distribution, biodiversity, health and integrity of cold water corals and sponges in the LC MPA:
    - There is research ongoing on recovery from trawling and taxonomy of corals and sponges. Video is useful to identify known species but sampling is necessary to identify new species as small structures are needed for proper identification. Impact by drilling waste needs to be considered as is being conducted at the Oceans Science Center.
- RO 2: Identify important as well as sensitive marine benthic areas and habitats in the LC MPA by supporting the conduct of scientific surveys, mapping and habitat association studies.
    - There is existing information that can be used for habitat modeling and comparisons to other species. It was noted that part of this RO could include the impacts of RV trawling on benthic habitats.
- RO 3: Advance the understanding of plankton variability in the area and locations of enhanced productivity supporting benthos, fish and cetaceans.
    - Additional monitoring is needed to fill the gaps in this particular RO.
- RO 4: Advance the understanding of cetacean distribution, abundance and migration in the LC MPA.
    - Deployments of acoustic receivers could be strategically place in the MPA and in each reference area (less than 10 would be good) and there is an option for cheaper receivers. If there are differences between areas more receivers might be used. It is important to consider the additional cost for processing data.
- RO 5: Advance the understanding of the spatial and temporal distribution of sharks and shark bycatch, and quantify shark bycatch across all fisheries for species frequenting the LC MPA.
    - Observer coverage can be increased depending on the feasibility. It is also important to look at mortality in gears other than longlines. Research on avoidance mechanisms would also be of value, i.e. devices on gillnets to repel sharks. These devices could be important for industry given the economic loss resulting from shark entanglements in fishing gears. Research in this field could be a way to bring industry into the MPA monitoring process.
- RO 6: Advance scientific studies contributing to the identification and understanding of significant or critical habitat for SARA-listed species found in the LC MPA.
    - A better understanding of critical habitat is needed including densities of jellyfish.

SAR DOCUMENT

Presenter: Nadine Templeman

Abstract

Summary bullets were drafted for the Science Advisory Report (SAR). Participants suggested that the bullets include a concise description of the monitoring protocols and strategies for the LC MPA indicators.

Discussion

The following points were raised:

- It is important to highlight that the document presents a list of potential indicators, protocols and strategies that have been reviewed during the meeting. More discussion is needed to finalize protocols and strategies and to define a detailed monitoring plan, which includes the experimental design, costs, and logistics which could be a task for the Scientific Advisory (Steering) Committee.
- Biodiversity is an indicator of the health of the ecosystem; however, it has not been discussed extensively. It is concluded that species diversity should be a direct indicator of the overarching goal. As discussed during the direct indicators section, the use of "taxonomic richness" is recommended. A further recommendation is to delete "biodiversity" considering that more indicators are needed to measure biodiversity and that the LC MPA process has identified COs, which is a high level of specificity.
- Related to the biodiversity issue is the "community structure and function" discussion. Potential indicators could be grouped into one category depending on whether the term can be left as a broad aspect or more specificity is needed. Some indicators might respond to the effect of the MPA and others might not. This is a question that needs more discussion.

RECOMMENDATIONS

The relevance of the COs in the long term needs to be examined on a continual basis as part of the ongoing monitoring and evaluation process of the MPA. Adaptive Management Approach is important as it will allow for potential modifications of the MPA in the future as well as identifying ROs and to add potential COs as new information becomes available. As such, an Ecosystem Approach needs to be considered further.

The indicators, protocols and strategies selection process should be hypothesis driven. The reference areas are key for the assessment of the MPA functioning and effectiveness. Uncertainty should be taken into account because the indicators identified are a result of an initial proposal and a proper experimental design will allow for measuring changes in the region.

It is recommended that satellite observation and oil activity databases be updated every year. Some databases could be analyzed every few years, since it requires significant effort to conduct every year considering the ultimate goal of identifying patterns and trends.

REFERENCES

Baillon, S., Hamel, J.F., Wareham, V.E., and A. Mercier. 2012. Deep cold-water corals as nurseries for fish larvae. Front. Ecol. Environ. 10: 351–356 doi:10.1890/12002210.1890/120022

Kenchington, E., Lirette, C., Cogswell, A., Archambault, D., Archambault, P., Benoit, H., Bernier, D., Brodie, B., Fuller, S., Gilkinson, K., Lévesque, M., Power, D., Siferd, T., Treble, M., and V. Wareham. 2010. Delineating Coral and Sponge Concentrations in the Biogeographic Regions of the East Coast of Canada Using Spatial Analyses. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/041. vi + 202 pp.

Lewis, S., Ramirez-Luna, V., Templeman, N., Simpson, M.R., Gilkinson, K., Lawson, J., C. Miri and R. Collins. A Framework for the Identification of Monitoring Indicators Protocols and Strategies for the Proposed Laurentian Channel Marine Protected Area (MPA). DFO Can. Sci. Advis. Sec. Res. Doc. In press.

TABLES

Table 1. Summary of Proposed Direct Indicators in the Laurentian Channel Marine Protected Area.

Species	Direct Indicator	Hypothesis
Overarching Goal	Biodiversity	Biodiversity will be maintained or increased within the LC MPA relative to the reference area
Sea pens	Biomass	Biomass is expected to increase or be maintained with the reduction of harm inside the MPA as compared relative to a reference area
Sea pens	Size distribution	The size range of sea pens should increase or be maintained especially larger individuals by reducing the risk of human induced mortality inside the MPA and outside
Sea pens	Geospatial indicators	Patch stability, connectivity and area should increase or be maintained with the reduction of harm due to human activities as compared to outside areas of similar structure
Sea pens	Taxonomic diversity and richness	Taxonomic diversity and richness should increase or be maintained as a result of reduced disturbances to population compared to outside area
Sea pens	Abundance and density	Number of individuals should increase or be maintained relative to reference areas
Black Dogfish	Biomass	Biomass is expected to increase or be maintained with the reduction of harm inside the MPA relative to a reference area
Black Dogfish	Size distribution	Size distribution should increase or be maintained with reduction in harm, in particular pups, and larger individuals relative to a reference area
Black Dogfish	Abundance	Number of individuals should increase or be maintained relative to reference areas
Black Dogfish	Mean life span	The mean life span should be expected to increase or be maintained if there is a reduction in harm to black dogfish from human activities
Smooth Skate	Biomass	Protection measures should result in increase or maintain biomass of smooth skate within the MPA relative to reference area
Smooth Skate	Size distribution	Larger proportions of YOY and reproductive females should result or be maintained from protection of the MPA relative to a reference area
Smooth Skate	Abundance	Number of individuals should increase or be maintained relative to reference areas
Smooth Skate	Mean life span	The mean life span should be expected to increase or maintain if there is a reduction in harm to smooth skate from fishing
Porbeagle Shark	Lethal encounters with fishing gear or vessels, immediately non-lethal entanglements	There will be fewer mortalities resulting from human activities relative to the reference areas
Porbeagle Shark	Occurrence and frequency	Increase number of sightings of porbeagle

Table 1. Continued.

Species	Direct Indicator	Hypothesis
Northern Wolffish	Biomass	Numbers of Northern Wolffish should increase or maintained over the long term resulting from protection of the MPA area relative to reference
Northern Wolffish	Size distribution	The range in size should increase or be maintained with reduction in harm relative to the reference area
Northern Wolffish	Mean life span	The mean life span should be expected to increase or maintained if there is a reduction in harm to Northern Wolffish relative to the references
Northern Wolffish	Occurrence and frequency	Number of individuals should increase or be maintained relative to reference areas
Leatherback Turtle	Lethal encounters with fishing gear or vessels, immediately non-lethal entanglements	There will be fewer mortalities and injuries resulting from human activities relative to the reference areas
Leatherback Turtle	Occurrence and frequency	Increase number of sightings of leatherback

Table 2a. Summary of Proposed Indirect and Anthropogenic Indicators in the Laurentian Channel MPA - Ecosystem status and trends.

#	Indirect Indicators
1	Temperature, salinity, oxygen concentration, alkalinity, light levels, chlorophyll, pigments, nutrients, currents, and pH of bottom waters inside and in adjacent waters to the MPA.
2	Water mass movements
3	Extent of ice cover inside and in water adjacent to the MPA.
4	Sound speed as a proxy for pH
5	Acoustic backscatter
6	Gas seeps and pockmarks
7	Nutrient flux between the sediment and water
8	Sediment composition and chemistry
9	Underwater sound produced by cetaceans, as well as the other natural and anthropogenic sources.
10	Community (benthic and pelagic) function and structure (species distribution, trophic structure (predator/prey), energy flow, etc.)
11	Primary production
12	Habitat

Table 2b. Summary of Proposed Indirect and Anthropogenic Indicators in the Laurentian Channel MPA - Secondary Indicators for the COs.

#	**Secondary Indicators for the COs**
1	Jellyfish aggregations inside and in adjacent waters to the MPA Species: Cyanea capillata (most common) and *Aurelia aurita*.
2	Occurrence and/or frequency of turtles
3	Occurrence and/or frequency Porbeagle and other sharks
4	Occurrence and/or frequency Northern Wolffish

Table 2c. Summary of Proposed Indirect and Anthropogenic Indicators in the Laurentian Channel MPA - Anthropogenic Stress Indicators.

#	Anthropogenic Stress Indicators
1	Distribution of commercial fishing effort in adjacent waters to the MPA impacting the COs
2	Compliance inside MPA
3	Incidence of bycatch and discards of COs and ROs in adjacent waters to the MPA.
4	Infrastructure such as number and types of seabed cables, offshore-petroleum exploration and development activities, etc. inside and in adjacent waters to the MPA.
5	Number of ballast-water exchanges within or in proximity to the MPA and the quantities of ballast exchanged
6	Oil spills (vessel sources)
7	Oil and gas discharges
8	Seismic survey activities
9	Quantity of anthropogenic debris inside and in adjacent waters to the MPA.
10	Number of incidents of ship strikes in the MPA and in adjacent waters.
11	Quantitative characteristics of anthropogenic sound within the MPA compared to adjacent waters.
12	Number of transits of the MPA by vessels other than pleasure craft, broken down into mercantile vessels, surface naval vessels and fishing vessels not fishing in the area.
13	Seabed area swept by bottom-tending mobile research and monitoring gear within the MPA, both as a total and subdivided by seabed habitat type.
14	Biomass removed from research surveys within the MPA

Table 3a. Summary of Proposed Protocols and Strategies for Monitoring Indicators in the Laurentian Channel MPA - Direct Indicators Survey Methods.

Direct Indicators Survey Methods	Indicators Application	Status
DFO Multispecies Bottom Trawl Survey	Fish species; corals and sponges	Ongoing
Shark Longline Survey	Porbeagle (shark species)	Not planned
Coral surveys (camera, box core, ROV)	Corals	Planning
Tagging (passive acoustic – sharks)	Porbeagle/sharks	On going
Aerial Flights	Turtles/Cetaceans	Planning
Bottom Mooring (acoustic)	Cetaceans/other community species	Planning

Table 3b. Summary of Proposed Protocols and Strategies for Monitoring Indicators in the Laurentian Channel MPA - Indirect Indicators Survey Methods.

Indirect Indicators Survey Methods	Indicators Application	Status
Bottom moorings (oceanographic)	Oceanographic	Planning
AZMP	Oceanographic	Ongoing
Dockside monitoring	Anthropogenic/fish species	Ongoing
At sea observers	Anthropogenic/fish species	Ongoing
Multibeam Acoustic Surveys/benthic grabs	Habitat/ecosystem	Processing

Table 3c. Summary of Proposed Protocols and Strategies for Monitoring Indicators in the Laurentian Channel MPA - Anthropogenic Indicator Survey Methods.

Anthropogenic Indicator Survey Methods	Indicators Application	Status
DFO databases (logbooks, landings, etc)	Fishing effort; bycatch; compliance	Accessible
DFO Vessel Monitoring Systems (VMS)	Compliance; traffic inside MPA	Accessible
DFO Fisheries Protection Program – Program Activity Tracking for Habitat (PATH)	Infrastructure and human activities	Accessible
Partner information (e.g. Transport Canada, Environment Canada, CNLOPB)	Infrastructure; seismic surveys; sound; ship strikes	Accessible

APPENDIX I: TERMS OF REFERENCE

Regional Peer Review – Newfoundland & Labrador Region

June 24-26, 2014

St. John's, NL

Chairperson: Dr. M. Robin Anderson

Context

Under the Health of the Oceans (HOTO) initiative, DFO Science is required to provide support and advice on Marine Protected Areas (MPA) to DFO Oceans. Currently, this includes the identification of indicators, protocols and strategies that are to be incorporated into MPA monitoring plans to be carried out by Oceans. The indicators, protocols and strategies are to be based upon the regulatory conservation objectives (COs) set out for each particular MPA. For the proposed Laurentian Channel MPA, there are six (6) primary conservation objectives associated with the conservation and protection of corals (sea pens); Black Dogfish; Porbeagle shark; Smooth Skate (juvenile); Leatherback sea turtle; and Northern Wolffish. Given that this MPA is located offshore, the monitoring strategy will likely have minimal community input and will rely heavily on opportunistic resources (e.g., existing DFO monitoring/research; external collaborative monitoring/research; outsourcing of monitoring/research).

Monitoring ecological indicators in an MPA is essential to: a) develop a broader MPA monitoring "plan" or "program" (which would include socio-economics); b) track status, condition and trends to determine if the MPA is effective in achieving its COs; c) aid mangers to adjust MPA management plans to achieve conservation objectives; and d) report to Parliament and Canadians. Science advice on MPA monitoring is intended to focus on biological/ecological aspects of monitoring (including potential threats to COs). In the specific case of the proposed Laurentian Channel MPA, Research Objectives have also been identified where it is known that baseline information for ecosystem components of interest is currently lacking. Research monitoring activities to inform information gaps related to these objectives will be useful to future considerations for MPA management.

The selection of indicators, protocols, and strategies for the collection and analysis of data must be scientifically defensible. Scientific advice will include specific information regarding the best indicators for MPA conservation objectives; protocols (methodologies) for acquiring these indicators; as well as suggestions (when available) for strategies in obtaining this information (e.g., RV surveys; ships of opportunity; academic and other research, etc.). As per MPA best practice, identifying baseline information (i.e., existing status and trends of indicators and species of interest for the COs) is invaluable to monitoring programs and reporting against conservation objectives.

Objectives

The intent of this science peer review process is to recommend a suite of indicators that can be used to monitor status and trends of the ecological components of interest within the Laurentian Channel AOI (MPA). One significant challenge will lie in distinguishing which changes are due to natural and/or anthropogenic stressors such as climate change, industrial development, etc. Another challenge will be the ability to draw conclusions based on incomplete and limited data currently available for the Laurentian Channel and the proposed MPA area as most existing data are collected for reasons other than MPA monitoring (i.e. DFO monitoring and/or research surveys).

Along with drawing on existing data, there will be a need to identify and prioritize gaps in data (and potentially indicators) to point to what new data should be collected in future. For the Laurentian Channel AOI (MPA) monitoring plan to succeed, it will be necessary to keep the science advice clear, concise, and easy to communicate to the main audiences which include the ministers of the Crown; industry stakeholders; and the public at large.

The objective of this meeting is to provide a scientific peer review of a proposed Laurentian Channel MPA monitoring framework to determine:

1. What are the potential *direct* indicators that would be required to monitor the status of the Conservation Objectives (e.g., abundance, biomass, frequency, etc.)?
2. What are the potential *indirect* indicators that should be considered to assist in understanding status and trends from the direct indicators (e.g., environmental, condition/health, etc.)?
3. What are the protocols for acquiring indicator data? What are the minimum requirements and the optimal requirements?
4. Which of the potential indicators are/are not currently available/attainable through known existing surveys/activities in 3P?
5. How many and what type(s) of reference areas are required to adequately determine the effectiveness of the MPA in meeting its CO's? Where should the reference sites be located?
6. What are available or potential strategies (e.g., RV surveys; ships of opportunity; academic and other research, etc.) for carrying out the monitoring program?
7. What are the key data gaps in our understanding the life histories of species of interest in this area? I.e., is there an aspect of research that is required prior to/during MPA monitoring?
8. Where appropriate, what potential research monitoring activities can inform information gaps related to Research Objectives for the Laurentian Channel MPA?

This meeting will review one working paper, "A Framework for the Identification of Monitoring Indicators Protocols and Strategies for the Proposed Laurentian Channel Marine Protected Area (MPA)**,** prepared to identify indicators and associated protocols and strategies for the proposed Laurentian Channel MPA. The outputs from this process may then be used to inform the development of monitoring plans for the MPA, a component of the overarching Management Plan, required under Canada's *Oceans Act.*

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Participation

- Department of Fisheries and Oceans (Science and Ecosystems Management (NL and Maritimes)
- Newfoundland and Labrador Department of Fisheries and Aquaculture
- Memorial University of Newfoundland/Marine Institute
- Transport Canada
- Other

References

DFO. Laurentian Channel Area of Interest. Website.

DFO. 2011. Biophysical Overview of the Laurentian Channel Area of Interest (AOI). DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/076.

Templeman, N. 2007. Placentia Bay-Grand Banks Large Ocean Management Area Ecologically and Biologically Significant Areas. DFO Can. Sci. Advis. Sec. Res. Doc. 2007/052.

APPENDIX II: MEETING AGENDA

Hampton Inns & Suites, St. John's, NL

Chair: Robin Anderson, DFO

June 24th, 2014

Time	Activity	Presenter
0900	Opening Remarks & Introductions Review and approval of Agenda	*Chair*
0915	Context for Request for Science Advice	*N. Templeman*
0945	Review of Terms of Reference	*Chair*
1000	**BREAK**	*N/A*
1020	Approach to Monitoring Framework	*S. Lewis*
1040	Species of Interest Overview – Corals (Sea Pens)	*K. Gilkinson*
1100	Species of Interest Overview – Marine Fish (Black Dogfish; Smooth Skate; wolffish spp.)	*M. Simpson*
1200	**LUNCH** (not provided)	*N/A*
1300	Species of Interest Overview – Porbeagle Shark	*M. Simpson*
1320	Species of Interest Overview – Leatherback Sea Turtle	*J. Lawson*
1340	Direct Indicators	*S. Lewis*
1440	**BREAK**	*N/A*
1500	Indirect Indicators	*S. Lewis*
1600	Discussion	*All*
1630	**Meeting Adjournment**	*N/A*

June 25th, 2014

Time	Activity	Presenter
0900	Review of Day 1	*Chair/All*
0920	Anthropogenic Indicators	*S. Lewis*
1020	**BREAK**	*N/A*
1040	Protocols and Strategies – Direct Indicators	*S. Lewis*
1230	**LUNCH** (not provided)	*N/A*
1330	Protocols and Strategies – Indirect Indicators	*S. Lewis*
1430	Protocols and Strategies – Anthropogenic Indicators	*S. Lewis*
1500	**BREAK**	*N/A*
1520	Experimental Design Considerations	*S. Lewis*
1630	**Meeting Adjournment**	*N/A*

June 26th, 2014

Time	Activity	Presenter
0900	Review of Day 2	*Chair/All*
0920	Research Objectives Considerations	*S. Lewis*
1020	**BREAK**	*N/A*
1040	Discussion	*All*
1200	**LUNCH** (not provided)	*N/A*
1300	Science Advisory Report – Drafting	*All*
1430	**BREAK**	*N/A*
1450	Science Advisory Report – Drafting	*All*
1630	**Meeting Adjournment**	*N/A*

APPENDIX III: MEETING PARTICIPANTS

Name	Affiliation
Anderson, M. Robin	DFO Science, NL Region
Belley, Renald	Memorial University of Newfoundland
Beresford, Laura	DFO Oceans, NL Region
Collins, Roanne	DFO Science, NL Region
De Moura Neves, Barbara	Memorial University of Newfoundland
Devillers, Rodolphe	Memorial University of Newfoundland
Dwyer, Karen	DFO Science, NL Region
Edinger, Evan	Memorial University of Newfoundland
Fisher, Jonathan	Centre for Fisheries Ecosystems Research (MUN)
Gilkinson, Kent	DFO Science, NL Region
Gregory, Robert	DFO Science, NL Region
Gullage, Mardi	DFO Oceans, NL Region
Healey, Brian	DFO Science, NL Region
Kennedy, Eddy	DFO Science, MAR Region
Koropatnick, Tanya	DFO Oceans, MAR Region
Kuehnemund, Sigrid	DFO Oceans, NL Region
Lawson, Jack	DFO Science, NL Region
Lewis, Sara	DFO Science, NL Region
Mello, Luiz	DFO Science, NL Region
Morris, Corey	DFO Science, NL Region
Phelan, Fred	DFO Policy & Economics, NL Region
Power, Annette	DFO Oceans, NL Region
Power, Don	DFO Science, NL Region
Ramirez-Luna, Viviana	Contractor (Rapporteur)
Senciall, Dave	DFO Science, NL Region
Simpson, Mark	DFO Science, NL Region
Templeman, Nadine	DFO Science, NL Region
Wells, Nadine	DFO Science, NL Region

APPENDIX IV: PROPOSED CONSERVATION OBJECTIVES

1. *Current*: Protect corals, particularly significant concentrations of **sea pens**, from harm due to human activities in the Laurentian Channel MPA.

   Recommended: No change.

2. *Current*: Ensure that human activities in the Laurentian Channel MPA do not impair the reproduction and survival or disrupt important aggregations of **Black Dogfish**.

   Recommended: Protect **Black Dogfish** from human induced mortality in the LC MPA.

3. *Current*: Protect areas of **immature Smooth Skate** abundance and ensure that human activities in the Laurentian Channel do not impair the reproduction and survival of the stock.

   Recommended: Protect **Smooth Skate** from human induced mortality in the LC MPA.

4. *Current*: Ensure that human activities in the Laurentian Channel MPA do not impair the reproduction and survival of **Porbeagle**.

   Recommended: Protect **Porbeagle** from harm and human induced mortality in the LC MPA.

5. *Current*: Promote the survival and recovery of **Northern Wolffish** by minimizing risk of harm from human activities in the Laurentian Channel MPA.

   Recommended: No Change

6. Current: Promote the survival and recovery of **Leatherback Sea Turtles** by minimizing risk of harm from human activities in the Laurentian Channel MPA.

   Recommended: No Change