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 2024/033

Maritimes Region

Proceedings of the Regional Peer Review of Existing Data, Protocols, and Procedures for the Gully Marine Protected Area Ecosystem Monitoring Plan

Meeting dates: September 25-26, 2012
Location: Dartmouth, NS

Chairperson and Editor: Tana Worcester

Fisheries and Oceans Canada
Maritimes Region
PO Box 1006, 1 Challenger Drive
Dartmouth, Nova Scotia B2Y 4A2

August 2024

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
ISBN 978-0-660-72430-0 Cat. No. Fs70-4/2024-033E-PDF

Correct citation for this publication:

DFO. 2024. Proceedings of the Regional Peer Review of Existing Data, Protocols, and Procedures for the Gully Marine Protected Area Ecosystem Monitoring Plan; September 25-26, 2012. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2024/033.

Aussi disponible en français :

MPO. 2024. Compte rendu du l'examen régional par les pairs des données existantes, des procédures et des protocoles du plan de surveillance de l'écosystème de la zone de protection marine du Gully ; du 25 au 26 septembre 2012. Secr. can. des avis sci. du MPO. Compte rendu 2024/033.

TABLE OF CONTENTS

SUMMARY

A Maritimes Regional Peer Review of Existing Data, Protocols, and Procedures for the Gully Marine Protect Area Ecosystem Monitoring Plan was held September 25–26, 2012, at the Bedford Institute of Oceanography in Dartmouth, Nova Scotia. Participation in this meeting included Fisheries and Oceans Canada (DFO), Environment Canada, Parks Canada, Transport Canada, the Canada-Nova Scotia Offshore Petroleum Board, academics, non-governmental organizations, aboriginal organizations, the offshore petroleum industry and the fishing industry. The results of this meeting will be used to support development of a monitoring plan for the Gully marine protected area (MPA).

INTRODUCTION

The meeting chairperson, T. Worcester, welcomed everyone and thanked them for coming to the Maritimes Region Peer Review of the Existing Data, Protocols, and Procedures for the Gully Marine Protected Area Ecosystem Monitoring Plan. Participants (Appendix 1) introduced themselves; the Terms of Reference (Appendix 2) for the meeting were reviewed; and the Agenda (Appendix 3) was reviewed. The agenda was updated.

The objectives of this meeting were

- To provide a scientific peer review of available data for selected indicators identified in the *Gully Ecosystem Monitoring Framework* to determine the state of the Gully ecosystem.
- To provide recommendations regarding the appropriateness of available data and monitoring programs, protocols, and procedures to evaluate the effectiveness of the indicators identified in the Gully Ecosystem Monitoring Framework, and based on this, to recommend indicators that should be continued.
- To provide recommendations on protocol development or changes to existing monitoring protocols and strategies needed to effectively meet MPA monitoring needs.
- To provide recommendations on possible approaches to reporting on the state of the Gully ecosystem using these indicators.

There was some discussion as to what would be done about indicators for which no working papers were prepared or presentations made at this meeting. Since the monitoring framework presented a set of indicators that, when taken together, were considered to provide for adequate monitoring of the MPA, it was felt that there should be some discussion on why a particular indicator had not been addressed as well as possible next steps.

It was noted that this was the first time that DFO has investigated a monitoring framework for an MPA, and that it would likely be used as an example for the future.

DFO's Ecosystem Management Branch will consider incorporating recommendations originating from this meeting into the development of the Gully MPA monitoring plan.

ASSESSMENT

2010 MONITORING FRAMEWORK

Presenter: T. Kenchington

Rapporteur: T. Worcester

Presentation highlights

The 2010 *Monitoring Framework for the Gully MPA* (Kenchington 2010) included effectiveness monitoring and threats monitoring and emphasized baseline monitoring (including characterization studies). It was aimed at monitoring the Gully ecosystem, in the context that key aspects of this ecosystem (important functions and processes) are not yet well understood. It was also aimed at meeting the needs of MPA managers, with much consideration given to what monitoring is achievable with existing technology. At the monitoring framework review, it was agreed that low-value data may be worth collecting if associated costs were negligible, and it was recognized data with high scientific value might be unattainable due to cost. It was also agreed that some indicators may not be worth monitoring on their own but could be

valuable in the interpretation of other indicators. For example, information on water temperature might help explain shifts in nekton diversity. Some monitoring was needed to give managers swift access to answers to obvious questions. For example, ship strikes on northern bottlenose whales may not be reported, but DFO should be able to affirm that no such reports had been received.

Within the 2010 monitoring framework, 47 indicators were identified, though many of these required development of quantifiable sub-indicators. The 47 indicators would be monitored through 18 component programs, most of which aimed at being built around existing routine monitoring. The monitoring framework also included discussion on the governance of monitoring, including the suggestion to coordinate component programs through a Gully monitoring committee. Membership on this committee could include project leaders and an MPA manager co-chair. An annual Gully monitoring workshop was suggested to review the data, report on results and recommend changes to the program. Data management and reporting was touched on briefly, though changes in technology and reporting procedures would suggest re-evaluation of this aspect of Gully MPA monitoring.

Discussion

Reporting frequency of indicators was discussed. It was suggested that reporting frequency be indicator dependent. Data collected annually were not always analyzed in time for reporting in the same year. There was caution about building expectations around reporting in near real time unless money was available for the required technical support.

The importance of standardizing data collection methodology was reiterated. Once data are collected in a standardized manner, new methods for analysis could be developed over time. However, tradeoffs between collection of new data and analysis of existing data would need to be made in terms of budget allocation. When budgets are reduced, analysis of existing data might be considered as an interim measure but would not replace the need for collection of new data.

It was unclear to some participants how information might be interpreted or lead to management action once results for all 47 indicators are available. An annual workshop to review Gully MPA monitoring results would to provide an opportunity for discussion and more meaningful interpretation of data. At a minimum, participants felt it was important to be able to provide an explanation when a change is seen in one of the signature species of the MPA or in other species of concern. The collapse of the cod fisheries was advanced as an example of a major change that remains uninterpretable because of a lack of concurrent monitoring of lower trophic levels. Ideally, monitoring would provide an opportunity to detect early warning signals. Ultimately, data gathered through a monitoring program are a key source of feedback received by MPA managers. These data help define the context for the administration of existing conservation measures and are the foundation for future management changes.

There was further discussion on the types of management action possible within the context of the Gully MPA regulations. It is unknown whether regulations would be changed in response to monitoring results, but the ways in which they are interpreted could be. For example, ship traffic through the MPA could be restricted by new (international) regulations, if monitoring indicated that it was necessary.

It was noted that the Gully MPA has specific conservation objectives, and monitoring is meant (in part) to evaluate whether these have been achieved. It was suggested that indicators could be separated into those that were critical to monitor and those that were intended as supporting or contextual indicators.

LONGLINE SURVEY INFORMATION

Working Paper: Fishing in the Gully: Using the industry/DFO longline halibut survey and commercial index as an ecosystem monitoring tool. M. Vaughan and M.K. Trzcinski. CSA Working Paper 2012/48.

Presenter: K. Trzcinski

Rapporteur:T. Worcester

Presentation highlights

Two halibut longline indices were evaluated for the Gully MPA: the industry/DFO survey and the commercial index. Data available for the MPA from the industry/DFO halibut longline survey are from Station 85 (the only fixed station in the survey that falls within the MPA) from 1998 to 2005 and from 2008 to 2010. Data from the commercial index is available from fishing in the Gully MPA in 1998, from 2002 to 2004 and from 2007 to 2010. Neither index is a continuous series. Station 85 is not currently included in the Larocque Core Station Survey Sampling, which includes 77 core stations, likely because it was not a complete time series. Consideration should be given to how the halibut longline survey could be used if other MPAs were created on the Scotian Shelf.

The industry/DFO longline halibut survey uses large hooks that tend to catch larger groundfish species and is 100 percent observed unlike the commercial index which is observed 21 to 48 percent per year. Detailed sampling is done on a priority basis: halibut > cod > cusk > white hake > wolffish.

Results from the Gully MPA analysis included species richness, diversity (Shannon–Weaver index using biomass), top bycatch species (caught in 5 years or more) and catch rates (kg/1000 hooks/10 hours soak time). The Shannon–Weaver index because was originally developed for continuous variables (numbers) and it is unclear whether a discontinuous variable (i.e. weight) can be used. At present, the diversity indices are relatively flat (non-informative); however, they may provide useful information over time.

The industry/DFO longline halibut survey sample size has consistently been one set per year in the Gully MPA (except for those years when Station 85 was not fished at all). The number of commercial index stations in the Gully MPA has changed over time. While the optimum sample size is unclear, preliminary analysis indicates that a sample size closer to 20 might be more appropriate.

Based on data that have been collected to date, trends in some groundfish species at Station 85 are consistent with other abundance indicators for these species. For example, data from this station indicated a significant positive trend in halibut, no significant trend in cusk, a decline in white hake, and an increase in northern wolffish.

The usefulness of this survey as a monitoring tool for the Gully MPA is unclear. Currently, the surveys have a small sample size, limited coverage and high natural variability. There is also difficulty in correlating information collected in the surveys with information reported in fisheries logbooks. Recommendations include adding one or more fixed stations to the Gully MPA and/or requiring observers on the commercial index sets in the Gully MPA. Further work might include analysis of commercial index port sampling data, analysis of nearby fixed stations or comparison of Gully station results with results from other canyons. Risks include uncertainty in ongoing funding and the lack of long-term joint project agreements (JPAs). However, industry has a vested interest in ensuring the continuation of this survey.

Discussion

If it was thought that Station 85 was valuable for Gully MPA monitoring, efforts could be made to ensure it is conducted annually.

One important question to address is whether the survey provides a large enough sample size.

The difference between species richness and species diversity was discussed. Species richness is the number of species caught, species diversity includes the relative abundance of the species caught.

There was some discussion of multivariate versus univariate analysis. The data reviewed were considered to be multivariate but were being fit into a univariate diversity index. Originally, the analysis simplified reporting to managers by providing a single value that could be tracked over time. It was not intended to preclude more advanced analyses being used and reported. Also, only one station was being considered, though it was being monitored through time. It was agreed alternative analysis approaches should be examined. The importance of variance estimates was noted.

Given the hook-size selectivity in longlining, the survey is unable to sample the full range of sizes that may be present in the area, as the halibut survey selects for the largest groundfish. Hook size was discussed as a means to catch a greater number of species. It was stated that hook size does impact species composition, but bait plays a bigger role. The need to standardize hook size was emphasized.

Potential risks of this survey to species at risk (i.e., the species listed under SARA, the *Species at Risk Act*) were discussed. There has been no specific analysis of the impact of this form of monitoring on species at risk in the Gully MPA. It would be challenging to conduct such an analysis without current population abundance estimates for some of these species. It was suggested that impact to even a single individual SARA-listed species, would be important to consider.

Clarification was sought in the timing of the longline survey and commercial index. Both are conducted from June to August using much the same gear but at different locations; the survey is confined to fixed stations.

It was suggested that observers on the halibut survey could potentially be asked to conduct water sampling. However, because of time limitations, there would have to be tradeoffs between water sampling and other work.

It was suggested that this indicator (and others) should be more clearly linked to the Gully MPA conservation objectives.

While halibut is an important commercial species, it may not reflect conditions within the MPA due to its movement within and beyond the boundaries of the MPA. The following options were provided for consideration: 1) Eliminate the survey as part of MPA monitoring, 2) Continue to use the data as long as it is being collected, 3) Keep Station 85 part of the core stations, as a direct tie to the Gully, and 4) Add additional stations to the survey.

The spatial range of species caught in the halibut survey was discussed. Work on diffusion estimates is underway for several species. Halibut travel long distances and may just be transient in the area. A large percentage of halibut move fewer than 20 to 30 kilometers. This area is large compared to the Gully MPA, and many species are moving freely in and out of the system.

It was questioned whether expanding the number of stations analyzed (i.e. including stations outside the Gully MPA) would improve the usefulness of the analysis. It was noted that while

this might be easier than adding new stations within the Gully MPA, it would be important to know what the results for the larger set of stations were saying about the Gully MPA. It would be important to determine what a station represents.

It was suggested that the survey would not provide useful data for MPA management unless coverage was expanded to a minimum of 10 sets per year within the MPA, and that the commercial index data would only be reliable for MPA management if observers were on board. There were further suggestions of broadening the seasonal coverage (currently May to July) and conducting comparisons between the Gully and other canyons.

Funding sources for the halibut survey was clarified. The halibut survey is primarily funded by the fishing industry; DFO's portion is drawn from 5-year Joint Project Agreements and is not guaranteed beyond the end of the current agreement.

The importance of minimizing the potential impacts of longlines on northern bottlenose whales was noted.

MESOPELAGIC SURVEY INFORMATION

Working Paper: Mesopelagic Monitoring. T. Kenchington. CSA Working Paper 2012/47.

Presenter: T. Kenchington

Rapporteur:T. Worcester

Presentation highlights

The uniqueness of the Gully is evident below its rim depth at 150 m. Northern bottlenose whales feed on squid at depths of approximately 1000 m. In the Arctic Ocean, they largely feed on *Gonatus*. Evidence is incomplete for the Scotian Shelf population, but available data indicates they consume the same diet. Although *Gonatus* cannot be effectively caught with nets, it is presumed they are at depths where whales feed. In turn squid are presumably feeding at those same depths, although adult females do not eat while brooding.

The purpose of the study was to examine the potential food source of *Gonatus*. Annual midwater trawl surveys took place from August to September from 2007 to 2009 with an additional survey in March 2010. Up to four depth strata were sampled at four fixed stations in the Gully using double-oblique tows. Approximately 300 species of fish, large quantities of crustaceans and smaller numbers of squids were caught. Few *Gonatus* were caught and with the exception of three spent females there were no large individuals. They were not caught in sufficient numbers to explain the presence of whales. The squid may be at the bottom out of trawl range or adults and larger juvenile males may be outswimming the nets.

The following proposal was made for future monitoring:

1. When there is a two-week trawler time block available, continue the survey series as baseline monitoring/characterization. No shiptime was available in 2011 or 2012, and it is not promising in the coming years.
2. When trawler time is not available for full survey, do scaled-down sampling when the CCGS *Alfred Needler* transits to or from Newfoundland.

- two scientific staff per one-way trip
- two tows per year to 1250 m on the 'Main' station (in the Gully, just inside its mouth, an area with most northern bottlenose whales)
- detailed sampling on just two species for which sub-indicators would be developed

It was proposed to focus on *Benthosema glaciale* (715 g biomass and 370 individuals per standard tow to 1250 m on the 'Main' station in late summer) and *Meganyctiphanes norvegica* (245 g per standard tow in daylight and 1530 g at night). There was no diel pattern in net avoidance for *B. glaciale*. *M. norvegica* seemed better at avoiding the net during the day. The larger individuals of the population seemed to be caught. They are a swarming animal, so they can be caught in a big tow. More data remains to be analyzed.

Some crustaceans were unknown to science which makes it difficult to obtain a good measure of diversity if taxonomists are not available.

It was noted that DFO has no ongoing meso- and bathypelagic program. Work relies on volunteer labour and requires specialist skills. It may not be possible to maintain the program without support for ongoing work. Adding additional trawler time in the Gully may result in a loss of trawler time for another program, which may not be supported within the department.

Discussion

The approach of characterizing the ecosystem and then basing the monitoring recommendations on the assumptions made about how the ecosystem functions was appreciated. Using a detour of the CCGS *Alfred Needler* seemed like a practical approach. Understanding mesopelagic communities is important for our understanding of the whole Scotian Shelf, not just the Gully MPA, as little is known about these mesopelagic communities.

It was felt that this approach should be used in monitoring of all our MPAs, i.e., to figure out what the choke points are and to monitor those.

It was suggested that the IYGPT (International Young Gadoid Pelagic Trawl) approach be supplemented with a more visual approach, such as an ROV system. However, densities of these organisms are low. Cameras lowered through the water column when an ROV was deployed for coral work did not show much, although a change in lighting could offer improvements. Visual methods are also more complicated as deep organisms tend to be luminescent. It might be possible to use light sensors to trigger pictures, and light could be used as bait. Other canyon scientists are looking at these methods.

The motivation was to catch the food supply of *Gonatus* since squid were unable to be caught. MPA objectives call for protecting more than just whales, but even for that signature species, managers need to know why numbers change (if they do). It would be better to have forewarning of changes if possible and not just learn about a severe decline after it happens. Understanding and monitoring the deep pelagic system is important for both of those reasons.

The diet of northern bottlenose whales has been tested for fatty acid signatures and it was consistent with feeding on *Gonatus*.

It was questioned whether *B. glaciale* in the Gully MPA was a separate population. They move up and down in the water column, reaching the surface at night, yet they return to the canyon at dawn and are not all carried away across the banks on either side. Variations in biomass might differ inside compared to outside the Gully. It is considered unlikely that they are genetically distinct and unlikely that they are the offspring of Gully individuals. Larvae are in the surface waters, but a typical Gully adult may remain in the Gully. The use of acoustic tags on northern bottlenose whales would provide a 3-D signature of their dive pattern and help interpret feeding locations. It would then be possible to deploy a ROV in the feeding locations. Studies of feeding locations have been completed, though higher precision may be possible in the future.

There was a discussion concerning the identification of squid in the area. In 2007, squid taxonomist confirmed both north Atlantic species. In 2008 there may have been a third

undescribed species as well. In 2009 it was suggested that there is only one (morphologically variable) north Atlantic species. To date, consensus on the identification of squid has not been reached.

It was questioned whether the timing of the dive behaviour study overlapped with the mesopelagic survey. The study and survey occurred in different years. The 'Main' station was picked to be amidst the whale sightings. Many northern bottlenose whales were recorded around trawlers while mesopelagic work was in progress.

The importance of determining the diet of bottlenose whales was noted.

CORAL SURVEY INFORMATION

Working Paper: Coral and Seabed Debris Monitoring.

Presenter: T. Kenchington

Rapporteur: T. Worcester

Presentation highlights

The presentation pertained to Indicators 13 to 16 and 45.

Surveys were conducted from 1997 to 2011 in the Gully using various cameras: CAMPOD, NRCan 4K camera, and ROPOS. There is one long-term monitoring station established by the 2007 coral survey using ROPOS. The station is a grid of transects on the southern slope of Feeder Canyon 4. The survey was a vertical camera flown at a fixed height above the sea floor to obtain quantitative data. An oblique camera was also used to assist in coral identification. Positional data from ultra-short baseline acoustics was accurate to 10 m. Corals were identified to species; they can also be measured (size) but this has not been done. There was no zooanthid overgrowth or debris observed on the transect in 2007 but the technique has been successful in the past.

With a frequency of ten years, the next survey would occur in 2017. There is no ongoing coral ecology program in the Gully MPA. Abundance of corals and the number of taxa have been extracted from the video, but the diversity index has not been calculated. Size structure would be more expensive to analyze.

Discussion

The frequency (every 10 years) of the survey was based on cost and the relative slow response time of corals to changes in the environment.

It was questioned how representative the survey area is of the Gully. The location was selected because it was richer than some. The richest places are too hard to work at with an ROV because of fast water flow.

There was a discussion on the susceptibility of corals to changes in pH. Corals are expected to be sensitive to changes in pH, and this is the real risk in the Gully MPA. Outside the MPA, the biggest risk to corals would be human activity, particularly dragging impacts. Deep water corals may be less susceptible to pH change than the shallow water corals.

There was a discussion on which diversity indicator should be used: something that can compare or combine with the other survey gear or something specific to corals. It was suggested that size might be a more worthwhile indicator than simple species richness.

There was a question about how the effectiveness of this survey's approach would be evaluated in the Gully MPA and if there should be another meeting by the coral experts to discuss lessons learned. It was recommend that the survey be continued in 2017 as planned and to do further analysis at that point.

There was a discussion about associated species of corals and whether any changes in their composition should be noted. There was also a question as to why the indicators focus only on corals. It was suggested that the decision to focus on corals may have been cost related. It might be possible to see something of similar size to corals, but it would require zooming in to see the smaller shrimp. In addition, there is not a lot of mega-epibenthos besides corals on the transects. There would also be problems with interpretation, but these problems were not discussed. There had been discussions about doing a survey of the giant protozoans (*Xenophyophora*) but it was decided to focus the very high expense of ROV–based monitoring on corals.

PHYSICAL, CHEMICAL AND BIOLOGICAL INFORMATION

Working Papers: Monitoring of the Physical, Chemical and Biological Environment: Indicators 21–22. E. Head. CSA Working Paper 2012/54.

Monitoring of the Physical, Chemical and Biological Environment: Indicator 23. E. Head. CSA Working Paper 2012/58.

Monitoring of the Physical, Chemical and Biological Environment: Indicators 26–27. E. Head. CSA Working Paper 2012/55.

Presenter: E. Head

Rapporteur:T. Worcester

Presentation highlights

The current AZMP program measures temperature, salinity, oxygen concentration, light, chlorophyll pigments and nutrients in the water column close to the seabed. Alkalinity is not measured and the pH sensor is not routinely deployed.

Estimation of phytoplankton production through satellite data interpretation is under development. Once the methodology is developed, there is archived satellite information that could be analyzed. Zooplankton biomass is analyzed, but community composition is not routinely reported because there are 200 species, which is too many to report. So, zooplankton community composition could be documented, but it is not typically analyzed.

The program has settled on four stations in the Gully MPA: one in the canyon and three across the mouth. At these stations, temperature, salinity, oxygen, nutrients, chlorophyll, POM (particulate organic matter), phytoplankton pigment composition and absorption spectra are routinely measured. In addition, there are vertical zooplankton net tows (200 μm mesh) from bottom to surface (or 1000 m to surface) and vertically stratified zooplankton net tows using the BIONESS (Bedford Institute of Oceanography Net Environmental Sampling System) at the Gully station inside the canyon (only done at a few other stations). A strobe light is used to stun the zooplankton, preventing them from avoiding the net. Counts are done only when there is special funding available. Because of spatial patchiness in the krill (unlike in Roseway Basin where krill are everywhere), it may not be adequate to sample just the one station in the Gully.

Nitrate profiles are available for the Halifax and Louisbourg lines. The 0–50m nitrate profiles are averaged for spring and fall. Near bottom nitrates are also done from the research vessel (RV) survey.

There is no trawling done in the Gully, so the Gully MPA is interpolated from stations outside the MPA, resulting in misleading maps for that unique area.

There are integrated chlorophyll concentrations, but AZMP sampling is not ideal for examining chlorophyll, it is better for zooplankton.

There is satellite imagery available for standard areas (e.g., Eastern Scotian Shelf) for which standard chlorophyll concentrations are calculated every two weeks, sea surface temperature is reported, and production may soon be reported.

It is possible to determine the timing of spring and fall blooms. For example, there was an earlier and more intense spring bloom in 2010 and an even more intense one in 2012.

There is a generally increasing trend in SST over time.

A dedicated study in the Gully showed that chlorophyll concentrations in the top 100 m were higher in the Gully canyon and lower at the mouth of the Gully in April. In August, levels were lower and similar everywhere. These data could be used to set baselines.

Zooplankton biomass in the Gully was higher in April 2006 and lower in July 2007, the latter showing differences in biomass at different depths.

There was an attempt to combine all the data from all sources in the Gully MPA. It showed a seasonal cycle that reflects the life cycle of *Calanus*. This seasonality makes it important to consider what time of year sampling takes place.

A lot of data have been collected since 1999, including samples, but it has not been analyzed systematically.

Some outstanding issues were identified:

- Is one station sufficient? Currently, samples are only analyzed from the one station if money is available, so is there even support for doing more?
- All of the data need to be examined.
- There are two variables that are not currently analyzed: pH and alkalinity. There is an alkalinity monitor but it has not been used because it cannot go very deep.
- The ability to determine phytoplankton production is coming. Phytoplankton composition will never be determined (except for estimations from pigment composition). A Shannon-Wiener index for the zooplankton could be developed.

Discussion

There was feedback/advice on indicator wording from G. Harrison. He specified that Indicator 21 was meant to suggest a bottom-mounted sensor for data collection close to the seabed in addition to the casts from the surface through the water column. In addition, alkalinity and pH were meant to be measured for corals. While dissolved inorganic carbon gives pH, you cannot convert between alkalinity and pH. There is a pH meter on the CTD, but it is unsure if samples are being taken for its calibration.

Indicator 22 referred to standard AZMP sampling, whereas Indicator 23 is specifically satellite-based. Indicator 25 is meant to be an interpretation of the existing data. The intent was to do something more systematic, such as develop an algorithm that will convert satellite data into production information.

It was identified that the Continuous Plankton Recorder (CPR) could provide a diatom/dinoflagellate ratio for the Eastern Scotian Shelf as sometimes the CPR goes over the

Gully. There are also colour sensors that look at different wavelengths that can distinguish diatoms from everything else, providing a broad classification. If there was a coccolithophore bloom, it would also be seen in the satellites.

It was agreed to do the stations because it is easy to collect the data. There was an acknowledgement that the main problem is in analyzing and interpreting the data.

It was mentioned that the satellite data only consistently produce SST and ocean colour.

It was stated that the workload involved in producing an extra series of reports to annual workshops on Gully monitoring (on top of the existing AZMP reporting) would place a horrendous burden on the scientists concerned.

MOVEMENT OF WATER MASSES

Presenter: B. Greenan

Rapporteur: Worcester

Presentation highlights

In the 1998 Gully review, the limited data on movement of the water was considered a knowledge gap. A field program was assembled to obtain data over a full year to enhance knowledge of spatial and temporal physical variability and lower trophic levels. Four moorings were deployed from April 2006 until August 2007. One of the moorings had a sediment trap, but in June 2007, something sheared off the mooring (steel cable), so no data from the sediment trap was obtained. LADCP (Lowered Acoustic Doppler Current Profiler) profiles were also collected (full water current profiles).

Very strong currents were observed: 30 cm/s was expected, but currents reached 70 cm/s in the east–west component alone. This created an issue for the moorings in terms of lacking buoyancy. Current meters that would normally be at 200 m depth got knocked over to 700 m due to the strong currents.

A progressive vector diagram shows currents above the rim (average flow to the southwest) and below the rim (flow towards the north). There is no apparent strong interaction between water above the rim and below the rim although there is some evidence of a below-rim eddy/rotation, which could enhance retention. Deep flow into the canyon is about 3.5×10^4 m^3/s below 500 m which also implies a small upwelling.

There is a K1 tidal current that runs along the Gully canyon and is bottom intensified. The M2 is not as large and has no bottom enhancement. There is a huge amount of interaction between the K1 and M2 currents. This causes internal waves, which is very unusual. Inside the Gully was compared to outside, but this feature is absent on the Slope mooring. At low frequencies, flow in the Gully and Slope are similar. At diurnal frequency, the Gully is much higher than the Slope. At inertial frequencies, the Gully is much lower than the Slope. At semi-diurnal and higher frequencies, the Gully is much higher than the Slope. There is much higher bottom enhancement (2.5 times the variance) in the Gully. Twenty times the vertical mixing was observed below the rim depth compared to on the Slope.

This was a very intensive way to collect information. There was uncertainty regarding repeating the field program. It may be repeated only if there was a need to interpret other data that was being collected.

Discussion

Wind events can dominate in the top tens of metres. Above the rim, there is a general southwest flow, so particle tracking at the surface would just go with the flow.

Sessile benthic filter feeders need water rich in organic carbon. If the water is poor in organic carbon, they need increased flow, which is seen in the Gully.

The Gully is unique in terms of its physical features and water flow regime and there is a computer model in development to simulate the process.

Rich neritic production on the banks may get trapped in the Gully: passing zooplankton is eaten by myctophids in surface waters at night and then carried down below the rim depth. The enhanced vertical mixing would then move the energy even further down onto the benthos.

There was a question about AZMP: if it could measure anything that could help feed the model. It was suggested that a single deep mooring might be useful, but there is no deep water pH sensor that could be attached.

It was suggested that a pH study could be done in the Gully to see if pH differs from the source water outside the Gully. The source waters could then be monitored. However, it may not be that simple. There is a correlation between eutrophication and oxygen and pH, so it could be variable. If samples are collected and brought back to the lab, pH could certainly be monitored.

There was a question about flushing time in the Gully, and it is days, roughly, not weeks.

A question was asked about the depths of corals. They are at hundreds but not thousands of metres. Cameras have been down to 2500 m.

There was another question about pH and the AZMP suggesting that pH could be measured during AZMP at 500–1000 m.

Overall, this information could be used to contextualize other indicators; however, it also provides information on plankton. There was a question about time scales and seasonal variability. There is not much difference between a monthly average in October compared to April, and daily cycles are much more dominant that monthly cycles.

ACOUSTIC BACKSCATTER INFORMATION

Working Paper: Gully Monitoring Indicators: Acoustic Scattering. N. Cochrane. CSA Working Paper 2012/50.

Presenter: N. Cochrane

Rapporteur: T. Worcester

Presentation highlights

There are different types of frequency responses for different organisms. For example, decapod shrimps and euphausiids are quite different and fish are quite different again. So using two frequencies can separate euphausiids from fish.

There have been several acoustic surveys: the Gully mesopelagic survey lines (2007–2010), the Gully AZMP and earlier opportunistic sampling. For the AZMP and earlier opportunistic sampling, transect lines and sampling times were not standardized, so there is limited consistency in the sampling protocol. The mesopelagic survey was mostly done at only one frequency (38 kHz), although 120 kHz was also recorded in 2009.

Datasonics acoustic technology was used on 31 cruises that visited the (now) Gully MPA in 1984, 1989, 1990, 1992 and 1996 onwards in spring and/or fall. Four additional acoustic acquisition cruises passed near the Gully MPA. Data have been converted to a common format for at least two and sometimes four frequencies.

In terms of adequacy, the mesopelagic survey had a good design, high quality echosounder technology and possibly adequate calibration but often inadequate frequency coverage that could not separate fish from euphausiids. Datasonics is old technology with poor design but had a good frequency range, though inadequate calibration of the lower frequency means fish results are hard to interpret.

The risks are that these programs have ended. Datasonics gear installed on the CCGS *Hudson* is 30 years old and is broken. It is thoroughly obsolete and it was advised that it should not be repaired. The CCGS *Hudson* is not easily adapted to multiple frequency surveys since it is not suited for the fitting of multiple modern survey transducers without major modifications. In addition, acoustic expertise is in short supply at BIO.

It is recommended that modern scientific sounders with good calibration and expertise should be developed at BIO (some available at the St. Andrews Biological Station). Future surveys should be done at two frequencies minimum (preferably more). Commonly used frequencies internationally are 38 and 120 kHz. Surveys would be best done on the mesopelagic survey with its standardized sampling profile using the AZMP to supplement (running the identical mesopelagic survey lines during the night).

Temporal variability was not reliably discerned by infrequent ship-based surveys, so long-duration (5 or 6 months), upward-looking, moored echosounder deployments are recommended to fill this gap. It was also stated that vessel surveys are still valuable. ASL Ltd. manufactures a dual frequency, self-contained echosounder suitable for bottom deployment. The St. Andrews Biological Station has bought one to use in the Bay of Fundy which could be deployed near GULD4 to monitor pelagic fish and near GULD3 to monitor euphausiids. Finally, with additional frequencies, populations could be separated out.

Discussion

There was a question about the relationship between biomass and backscatter. If all the scatter mix remains the same, there is a linear relationship, but it is harder to interpret if the mix varies.

A question was asked regarding the need for a tether on the echosounder. Since it cannot go below 600 m, it does need to be on a mooring.

A question was asked as to the cost of an ASL unit and the answer was $45 000.

A question was asked as to the range of detection and the answer was 150–200m for a 120 kHz sounder.

A question was asked as to the ping repetition rate. The ping repetition rate is lower than in the ship surveys; it is programmable and can ping once every ten seconds. For a long-term deployment, less-frequent pings would still generate usable data.

There was a comment about monitoring when species are separated, not mixed, or monitoring at night when organisms are at the surface. For example, at the Gully mouth, myctophids would be observed.

It was stated that this is temporal information (long time series) that might support the other surveys. However, one echosounder might not give enough information; broader spatial coverage and broader temporal coverage are needed. With fixed moorings, anything spatial

cannot be resolved, but temporal information can be obtained. If the information is integrated with the infrequent ship surveys, some better analysis could be performed.

There was a discussion about the possibility of using dual frequency on the CCGS *Hudson*. It was stated that it could be done on the *Hudson* if there was real resolve, but politics does not allow it (i.e. the use of transducer ram). It is not recommended to tow transducers. If only the relative patchiness was desired, one pass could be done with the ship-based system. This could be used to refine the moored sampling location.

There was a question about whether a mooring weight is left each time that an upward-looking echosounder is deployed: yes. It was then suggested that this might be a problem if it is done every six months for ten years.

There was a question about the acoustics on the CCGS *Hudson* replacement. They had wanted a drop keel but are uncertain whether the request will go through. Given the proposed size of the vessel, it would be impossible to install a drop keel, so it is better if the ship is designed to do acoustics. There was a recommendation that the CCGS *Hudson* replacement include consideration of acoustics.

SEABIRD INFORMATION

Working Paper: Gully MPA Monitoring Review: Seabird Monitoring CSA Working Paper 2012/53.

Presenter: C. Gjerdrum

Rapporteur: T. Worcester

Presentation highlights

PIROP data: 1966–1992, only 26 km surveyed in the Gully MPA.

ECSAS: 2006–present, 1393 km surveyed within the Gully MPA.

PIROP(Programme intégré des recherches sur les oiseaux pélagiques) and ECSAS (Eastern Canada Seabirds at Sea) use ships of opportunity, focusing on DFO research vessels but also using petroleum industry supply vessels, container ships, ferries, lobster boats and so on.

A standardized protocol is used for surveys. All birds occurring within 300 m of the ship are recorded during a five-minute survey. Bird behaviour, ship position and environmental conditions are recorded. Distance sampling is used which can measure avian diversity (ie. species can be counted).

In the Gully MPA, numerous dovekie, great shearwater, black-legged kittiwake, murres and storm petrels are seen. However, dovekie are only around in the winter. Seasonal variation is not captured, similar to the other surveys. In addition, rare species (e.g., the Bermuda petrel and another petrel species) may not be detected. Seabird density and distribution can be quantified.

Some upgrades were proposed. Since temporal trends cannot be determined, more frequent surveys to capture seasonal variability, more systematic surveys or habitat modeling to account for observed variability would be needed. In addition, seabird behaviour, associations and flight direction could be emphasized more than in standard ECSAS protocols. It was suggested that protocols be compared and that joint opportunities with the cetacean surveys should be sought.

There is no targeted funding for these surveys in the Gully MPA, but they will continue.

While trends in the Gully MPA could not be described, broader scale trends outside the Gully could be examined. A baseline is still being established and could be completed once seasonal variation has been determined.

An interesting research avenue was suggested: What are the physical and biological features that explain the observed seabird distributions?

Discussion

There was a question as to the uniqueness of the Gully seabird population. The species composition is not different, but the use of the Gully is significant. All the data have been reviewed to determine important areas for seabirds, and the Gully stands out despite the lack of data in the area.

There was a question as to whether any of the birds can dive as deep as 200 m. The question was asked because if the canyon does not influence the surface water, why would the birds be there? The answer was that diving so deep was not common. The bird surveys are only daylight surveys; it would be interesting to look at zooplankton surface distributions compared to other areas.

The strongest signal is from the deeper diving birds (80–160m), the alcids. But the most common species seen in the Gully are not those alcids. It was suggested that interactions between cetaceans and seabirds during foraging activity might be considered.

A clarification was made that oil and gas vessels do not enter the Gully.

There was a question as to the birds' prey in the Gully. Birds prey on mostly krill and zooplankton while storm petrels are just on the surface. Piscivorous birds eat mackerel, sandlance and squid.

There is interest in knowing more about foraging at night, between dusk and dawn. Many marine zooplankton species come to the surface at night and deeper-diving birds tend to be larger and would therefore seek larger prey.

CETACEAN INFORMATION

Working Paper: Gully Monitoring Indicators: Cetaceans CSA Working Paper 2012/57.

Presenter: H. Whitehead

Rapporteur: T. Worcester

Presentation highlights

Indicators 1 through 7 relate to the study of cetaceans. It was mentioned that scars could have been studied, but this has not been done as of yet. In addition, studying genetic diversity should not be necessary for another 10 years. Studying contaminants in blubber would be useful in a few years since it has not been looked at recently, but generally it need only be repeated at long intervals. The presentation focused instead on abundance of northern bottlenose whales and the presence/activity of other cetaceans.

Mark/recapture methods have been used on photo-identification data. Over time, photo-identification has moved from film (1988–2006) to digital (2007–2011) photography. Almost all individuals in the Scotian Shelf population of northern bottlenose whales can now be identified.

The current closed population estimate is 143 (127–158) northern bottlenose whales, excluding calves, within the Scotian Shelf. This is slightly below the open population estimate. There are

no apparent trends, so it is assumed that the population has remained fairly constant. Survey efforts have been targeted at two years back-to-back of intense survey effort repeated every few years.

Other whales have also been looked at incidentally from 1988 to 2011 in the summer months (mostly July and August, some June and September). Northern bottlenose and sperm whales have been targeted by surveys and so have biases in the data when treated as incidental sightings.

Most sightings have been in Zone 1, though there are many observations in other parts of the Gully and the other two canyons.

Temperature data that was collected indicate that there has been an increase in SST over the time series. There is much more fog in June than August; sighting rates are reduced below a visibility of 1000 m and in wind speeds above 4 on the Beaufort scale.

Cetaceans sighted include white-sided dolphins, common dolphins and pilot whales. See working paper for complete list. Minke whales prefer Zones 2 and 3 and Sowerby's beaked whales, white-sided dolphins and common dolphins prefer Zone 1.

Sowerby's beaked whales were sighted more frequently in the Shortland and Haldimand canyons than in the Gully; other species did not seem to show a preference for a particular canyon. The 'canyon' term was retained in the model.

White-sided dolphins were sighted most often in June, common dolphins were sighted most often in July and striped dolphins and pilot whales were sighted most often in August.

Trends in the data show blue whales, pilot whales and Sowerby's beaked whales to be increasing—the latter, previously never sighted, have been increasing at an extraordinary rate of 21% per year. Fin whales, humpback whales and white-sided dolphins showed a decreasing trend. Striped dolphins had a slight downward trend, and common dolphins had no discernible trend.

The trends in sighting rates could be due to changes in population or changes in distributions of food, competition or disturbance (predominantly sound). There have also been other changes in their biology.

- Blue whales – possible increase in overall population (not the 11% observed in the Gully) and increasing food (euphausiids).
- Fin whales – possible decrease in population or reduced food (fish) in the Gully.
- Humpback whales – have been increasing elsewhere but not in the Gully. May be related to food (decreasing fish?).
- Sowerby's beaked whales – rate of increase in observations is much faster than the maximum rate that the species could increase in abundance. Individuals must be moving into the area from elsewhere. There is uncertainty as to whether this is related to food or due to changes in disturbance.
- Pilot whales – possible changes in population size and possible disturbance.
- White-sided dolphins and striped dolphins – may be population change and food.

There is a feeling that the Gully MPA has gotten quieter in recent years due to fewer fishing vessels, absence of seismic activity as in the 1990s and absence of Concord's sonic booms which were occurring until 2005. Other *Mesoplodon* species are known to be sensitive to sound disturbance.

Discussion

There was a question as to the diet of Sowerby's beaked whales. They are fairly deep divers, so possibly they feed on mesopelagic species and squid. They do not dive as deep as northern bottlenose whales.

A point was made that Sowerby's beaked whales seem to prefer the Shortland and Haldimand canyons, which are not protected. These data might not support the proposed noise hypothesis.

There was a question about whether population estimates from elsewhere exist and if the Sowerby's beaked whales are coming from somewhere else. A transect was conducted from the US, northward into Canadian waters. On the US side of Georges Bank, there were a lot of Sowerby's whales observed, but they were not observed much elsewhere.

It was asked what the temperature range was for Sowerby's beaked whales; they are found off Davis Strait, so a change of 1 degree would not explain the increase in Sowerby's.

There was a discussion on sources of noise in the Gully. The current source of noise would be merchant ships passing through the Gully, and it was asked how the intensity of noise of merchant ships differed from noise of seismics. The frequency of noise from merchant ships would be below the hearing range of acoustic systems used in the Gully, so comments cannot be made on these changes based on listening to the acoustic records.

There was a question as to the size of pods. It is hard to estimate because of the variability in pod size. How estimates of group size have changed over time has not been examined. It is possible that there could be smaller pods but more of them. It was agreed that this should be examined, and a recommendation was made that the influence of pod size on the results should be investigated further.

There was a comment that views on trends in noise are totally qualitative. It was asked whether there were plans to examine H. Whitehead's audio tapes and tease out such data. The response was that it was unlikely because recordings were very shallow with lots of wave noise and were not calibrated, among other issues.

Working Paper: Gully Monitoring Indicators: Cetaceans Interactions CSA Working Paper 2012/56.

Presenter: H. Moors

Rapporteur: T. Worcester

Presentation highlights

Indicators 9 to 12 relate to human interactions with cetaceans. There are few data on the human interactions within or outside the Gully MPA (other than noise) so they were not discussed. Only 9 entanglements (8 prior to 2004 and 1 after 2004) have been reported. In the 1960s and 1970s, 87 cetaceans were killed by whaling and one mortality was linked to military sonar. There have been recommendations by some to increase at-sea observer coverage, but the financial implications need to be taken into consideration before implementation. There are problems with reporting of incidents, and when reports do occur, they may be far from where the incident itself occurred. There is uncertainty as to what they say about the state or effectiveness of the Gully MPA.

Indicator 8 relates to cetacean presence and activity in the Gully MPA. There is limited interest in going to the Gully MPA in the winter in small craft, so passive acoustic monitoring has been suggested as a monitoring tool during this period. Pop-up recorders have been deployed, but with only one summer and one winter deployment at each location, there is no ability to look at

inter-annual variability. There are more than 3100 hours of recordings, so automated signal detectors were developed (for northern bottlenose whales). The output is the total number of clicks and the time that each detection occurred. Accuracy rates were determined (false alarm rate was ~2%). There was no difference in click presence or rates between summer and winter, but whales are using locations differently between the seasons. The area between the Gully and Shortland Canyon was not significantly different from inside the canyons themselves. The centre of the Gully is used more in summer. There is decreased activity in the day with significantly higher activity at midnight than at noon, presumably due to diel foraging behaviour.

For other species, there are some acoustic data and methods available: OBS, pop-up hydrophones, AMAR (test) and AMAR (future). In the future, AMAR deployments could take place for 6 to 8 months. Baleen whales and sperm whales could be examined among others. Automated detectors would need to be developed for these species, and the effective recording range for each system would also have to be determined. It would be hard to compare pop-up results to AMAR. There would be two dedicated units outside the Gully MPA (between Shortland and Haldimand canyons and between Shortland Canyon and the Gully). The cost would be $32 000 per unit plus deployment.

Discussion

There was a statement that tagging data do not show the diel patterns and northern bottlenose whales may be doing other things at the surface during the day. Their social vocalization behaviour is unknown.

Units have been deployed to depths of 2000 m. The depth range could be provided by Jasco, the provider. Monitoring is not in real time, and it has to be analyzed after the fact. Real-time monitoring is more difficult. Instruments can be deployed from a vessel, but more work is needed to make this operational. An off-the-shelf package should be available in a few years.

There was a question as to the range of the pop-up hydrophones and the response was 1 to 2 km. Sperm whales are louder, so they can be heard from further away than northern bottlenose whales.

The detection range for AMARs will have to be determined. There are some estimates in the literature for baleen whales.

Unlike pop-ups, a large vessel is needed to deploy the AMAR recorders. It is not known how to make them more compact. Options for deep water deployment are more limited.

Pop-ups have a limited frequency range. There is a need for up to 60 kHz, but they only went up to 25 kHz when H. Moors used them.

There was a question as to how many clicks one individual can make (in reference to click rate being a measure of activity). Inter-click rate varies within a click string. A minimum number of individuals being detected with a single recorder cannot be estimated easily.

There was a question regarding which indicators would be monitored when H. Whitehead retires. The answer was unknown. A small research platform is needed to do the cetacean survey, and it is uncertain as to whether DFO could do that given health and safety issues. The main issue is the height of the eye, though whales may be more attracted to small vessels compared to a large vessel. Whales can also be followed more easily with a small vessel. A low observation point on a large research vessel would not be of much help because a ship cannot manoeuvre quickly enough too close to the whales.

There was a discussion about tourist visits and if it presented an opportunity for data collection. Christie has collected data on the last two tourist trips, but there is not enough time to do a survey (only 1 to 2 days per visit). About 40 days are needed in the Gully MPA.

Other potential research platforms include DND's sail training yacht, *Tuna*, which may be available; efforts are underway to plan something related to this. DND does not have the same interest and would rather stay away from the Gully MPA.

REPORTING

One of the workshop objectives was, "To provide recommendations on possible approaches to reporting on the state of the Gully ecosystem using these indicators." To help facilitate discussion, J. Choi was asked to talk about how he reports on a series of indicators for the snow crab assessment.

Presentation: From complex to simple

Presenter: J. Choi

Rapporteur: T. Worcester

Presentation highlights

When we try to describe a system, we have physics envy. We try to describe what we think we understand and create a simple model. Between the simple and the very complex, there are 'middle number systems.' They are large, in that we cannot measure everything in them, but not large enough to have a central principle. There is sensitivity to the starting conditions, and things do not always repeat. Humans have an upper limit on the amount of information they can process, integrate and understand. The information content of real ecosystems greatly surpasses this upper limit, so we need to simplify things using other approaches.

We can either assume that something is good or bad using *a priori* 'norms,' which are subjective but participatory, or assume no thresholds—just numerical description via multivariate methods. Multivariate analysis (ordination) compresses the information (50 indicators) into something more manageable (2 dimensions).

In the snow crab assessment, 60 metrics were identified: environmental factors, fish abundance, fisheries metrics, economic metrics, landings and so on. Metrics were scored according to their standard deviation, and no value was associated with green or red (just above or below the mean). The 1st Principal Component of the correlation matrix explained 17% of the variation, showing change over time. The red/green map allows you to identify visually where the coherence occurs. It helps in explaining to fishers what is going on in the environment.

A more traditional approach can also be used: multispecies ordination. A graphic representation (map) of the ordination provides a sense of the community composition. The first axis is temperature related and the second axis is depth related.

Discussion

There was a question about which indicators would be looked at. The response was that species or subsets of taxa could be looked at. A hierarchical nest of species or species groups could be used.

It was stated that data can have different sampling frequencies.

A question was asked as to which term should be used: metrics or indicators. Terminology was not considered important in this case.

There was a statement about how the indicators can all be looked at together or just pressure indicators. They can be weighted differently if there is reason to do so.

It could also be taken one step further using an elaborate multivariate analysis that is still descriptive. Quantitative methods could be used to determine number of states (analysis of variance) to help determine when they go outside the bounds of natural variability. There are a large number of resampling techniques (bootstrapping) that can be used to investigate the variance. A point was made to not just do the analysis on one axis, but on all axes.

There was a comment to not lose sight of the important individual indicators. Humans will need to pick out the red lights about which to be concerned. It was suggested to report on the PCA but to also include the individual indicators. The model does not do the thinking for you.

There was a question regarding whether there are enough data for the Gully MPA to say that it is different from other places and to do that kind of analysis. Holes will need to be filled and some assumptions must be made; however, there is a possibility of doing this type of analysis with the data available.

There was a comment about the need to understand the correlation between the variables being measured. An example was given that if 25 of the variables being measured are related to temperature, then it is likely that temperature will come out as ‘important’ and the model will be self-predictive.

A question was asked about whether the ecosystem information is used in the assessment model. It is used as context, but it would not be included in a model.

There was a question about how well the snow crab population follows the PCA and the answer was that it follows it well.

There was a statement about the need to consider how human impacts outside the Gully impact the populations inside.

Another comment was that there is a need to make a choice between putting our faith in the numbers or in the people who are interpreting the numbers. Not only must the correlation between the variables be understood, but there also needs to be agreement on what needs to be measured—not just using what we have.

There was a comment that making things transparent and communicating the key message to managers is what is ultimately useful. The choice of indicators is important, and if the indicators are unbalanced, a hierarchical approach can be used, or they can be trimmed. The process is an iterative one.

There was a comment complimenting the coloured, unitless approach.

A question was raised about whether the analysis should be done at the large scale so the different MPAs can be examined. Variables that are useful across the region could be picked, and then metrics that are also useful for the Gully MPA could be added.

It was mentioned that personnel would be required to implement this type of analysis for the Gully MPA. When asked whether someone would be needed to coordinate the reporting of the Gully MPA (or other MPAs), J. Choi responded that he could provide support.

A recommendation was made that the department identify a PY to coordinate MPA monitoring and some data analysis (including multivariate analysis if feasible). The work needs to be able to be replicated in time and explained. In addition, there are more MPAs coming online. It was stated that the PY does not have to be new and could be moved from another position.

It was suggested to add to the Summary Table whether data is adequate for this type of statistical analysis.

It was mentioned that plans and priorities for DFO do not include monitoring; they only talk about planning for new MPAs.

K. Frank has also done this analysis before. It was mentioned that the Gully MPA should not be considered in isolation. There is a group at DFO doing integrated assessments and it was asked whether they could be asked to produce these types of reports.

THREAT INDICATORS

Working Paper: Gully Monitoring Indicators: Anthropogenic Sound. N. Cochrane. CSA Working Paper 2012/51.

Presenter: N. Cochrane

Rapporteur: T. Worcester

Presentation highlights

The basics of noise in the marine environment were presented. Ships are the major contributor to anthropogenic noise in the marine environment. Higher frequencies are typically natural (e.g., wind, sea) and lower frequencies are anthropogenic. Seismics can include higher frequencies, echo sounders are higher frequency (12 kHZ–200 kHz) and military sonar is in the low kHz range.

There is no ongoing program, but acoustic recordings were conducted by DFO in the Gully MPA in 2003, 2005, 2006, 2010 and 2011. Recorders were placed over 1000 m depth. Recording durations were generally less than 25 days. OBSs were developed by GSC and constructed by Omnitech Electronics Inc. and AMARs were developed by JASCO. It would be useful to purchase another AMAR unit to place in the Gully along with the others being placed along the Slope. Existing datasets are too short and discontinuous to adequately characterize the noise variability. OBSs have a 2 kHz cutoff, which cuts off the toothed-whale characterizations. Hydrophones too close to the bottom limit dynamic range.

Recommendations were made for the following: long-term deployments, near-continuous coverage, noise recording to >30 kHz, low noise omnidirectional hydrophones, primary data collection near 1500 m depth contour, additional data gathering in top 100 m (in a shallower area of the Gully) and gathering of ancillary data for correlation (sea state, wind, precipitation and vessel traffic).

There are some data but not enough for a good baseline. Data from the 2003 Marathon survey could be reanalyzed using higher quality multibeam bottom bathymetry. It would better define our ability to accurately model noise levels in the MPA from future seismic surveys. It is considered of moderate importance. Data are needed from the oil industry on seismic array characteristics in order to model it accurately.

A comment was made that DFO is losing its acoustic expertise.

Discussion

There was a question as to whether DRDC did some work on noise in the Gully and if they have data that have not been mentioned. In 2001, Desharnais and Collison used sonobuoys to look at the upper layer.

It was asked why having three AMARs is necessary. Two are being used outside the Gully this year, but they could be moved inside the Gully next year. SARA will probably use the AMAR later to assess other species outside the Gully; it would be nice to have one for the Gully (or MPAs in general). There may be a third unit from JASCO short term, but it would need to be purchased for longer-term monitoring. Another one would be needed for shallow monitoring. Ideally, four systems would be deployed, but it will depend on funding. It would be impossible to do continuous monitoring with only one, and it is possible that the department could lose one.

It was asked whether there is a plan to collect ancillary data with the planned SARA AMAR deployments. Yes, they will collect temperature data, sea state, etc. from the weather buoys.

There was an inquiry about a proposal for a big acoustic program with DRDC in 2011. The response was that nothing happened with the proposal.

Working Paper: Gully MPA Monitoring Review: Indicators to Monitor Pressures. T. Koropatnick, D. Fenton, A. Serdynska, K. Curran and P. Macnab. CSA Working Paper 2012/52.

Presenter: T. Koropatnick

Rapporteur: T. Worcester

Presentation highlights

For Indicators 32 and 33, commercial demersal and pelagic longline fishing effort within and in close proximity to the MPA (10 NM buffer), data were taken from MARFIS in 1-minute grid cells. There was an increasing trend in demersal fishing effort (most in 2011) which is related to increasing the halibut quota. Pelagic effort was mostly outside the MPA. Using the number of sets is a simple approach, so there might be something better. The risks are that there are limitations in the logbook reporting and that there is supposed to be a move to a national database.

For Indicators 35 and 37, quantities of organisms removed by fishing in close proximity to the MPA, there was no trend. There were changes in catch versus effort. The fisheries included snow crab, sea cucumber and so on.

For Indicator 36, at-sea observer data and MARFIS data were used. The targeted species are halibut, swordfish and tuna. The top three bycatch species were cusk, white hake and cod. Discards (from 12 observed trips) were sharks, skates and wolffish. There is a need for better observer coverage in the Gully.

For Indicators 38 and 39, seabed impacted by bottom contacting gear, MARFIS catch and effort data, RV survey reports and research reports were analyzed. From 2005 to 2011, 17% of fishable cells were fished. This is variable over time and there was an increase in 2011.

For Indicator 34, unauthorized fishing in the MPA, it was not possible to do geographic searches, only keyword searches. They did not want to report on false positives. There were five incidents since 2004. The risk for this indicator is that aerial surveillance is expensive.

For Indicator 35, there was no reported coral bycatch from fisheries. There was some research activity during which a canyon wall was bumped.

For an unidentified indicator, the data was not worked up, but a protocol was proposed.

For Indicator 40, data from CNSOPB were used; these are available on the Internet. Data from 1999 to 2003 were analyzed and are currently being updated from the human use atlas. It would be possible to look at a different resolution; a 5-year resolution might not be useful. There are three wells within the 50 km of the MPA. The usefulness of tracking licences is undetermined.

For Indicator 41 there was no trend. Results are driven by a small number of spills. The CNSOPB archives are secure.

For Indicator 30, vessel transits from February 2010 to February 2011 were analyzed from LRIT 6-hourly position reports produced by the Canadian Coast Guard. In total, 497 tracks in 13 months were analyzed, averaging 38 transits per month. There was no obvious seasonal trend. Vessels are asked to avoid the Gully but can travel far in 6 hours. A check was being made to see if vessels could be asked to report more frequently, more often when they approach the Gully. Breaking down the data by vessel type and speed would also be beneficial. VMS was used for fishing vessels; vessels that were fishing were filtered out. The analysis was done for 2005 to 2010. Numbers were relatively constant through time; from 2008 to 2010 there were more fishing vessels than transiting. Average speed has not been calculated. The main risk is that while the data are good and always improving, in-house GIS expertise is limited, although something similar could probably be developed in R or MATLAB.

For Indicator 42, ballast water, there are alternative ballast water exchange zones (ABWEZ); one of which is close to the Gully (5 km). There is mandatory reporting. Data on ballast water exchanges from 2007 (6), 2008 (11) and 2009 (17) were analyzed. It was noted that track lines are inferred paths, so Gully avoidance would not be captured in the dataset. The water quality of water in exchanges in the MPA is unknown, although it is likely that it was at the end stages of exchange. It is unknown how much of a risk it is.

For Indicator 43, oil discharges, there is a national aerial surveillance program. The Gully is included in the surveillance whenever feasible. In 2011, 31 flights passed near the MPA. There were no detections within 100 km of the MPA from April 2007 to Dec 2011.

For Indicator 44, floating debris, a visual transect for large debris and a neuston net tow for small debris took place in the summer of 2008. Results showed there were 31.6 items/km^2 more inside the Gully than outside. There was a small sample size. Studying small debris was tedious; a large debris survey could be done more easily.

The majority of the information concerning the Gully was extracted from regional or zonal monitoring.

Some participants thought that these indicators have only a very indirect relevance to the MPA and that it would be better to monitor more directly (e.g., look at underwater sound rather than ship transits).

In summary, most indicators have data, some from outside DFO. A baseline is partly established. Indicators could be prioritized.

Discussion

For Indicators 32 and 33 there was a question about whether the set location was the start or the end point. This depended on the individual; it could be a start, middle or end point. It is an inconsistent approach, although MARFIS does include fields for both. Historically, the requirement to include both has not been pushed. The line is much longer than the location.

There was a concern about including effort outside the MPA in the indicator. While it may be useful for context, it should not be included in the analysis. Industry would likely be concerned. Perhaps just bottom longline effort in the MPA should be used because pelagic longlines cannot be spatially defined. The treatment presented only looked at those fisheries that operate legally inside the MPA. Others operate outside and so Indicator 33 needs to consider a wider range.

There was a question as to whether the catch information is at the same location resolution as effort.

For Indicator 36, a need to bump up discard and bycatch amounts to the unobserved trips was expressed.

For Indicators 38 and 39, there was a disagreement about combining the indicators. A feature measured in area (km^2) is being combined with one measured in length, but there is no measure of how far side-to-side a longline sweeps. This makes it hard to translate length into an area. Also, by combining data into 1-minute cells, the point of estimating the total area fished is missed. Instead, the percent of the Gully impacted is being measured, which is a different thing and not useful for the purposes of MPA monitoring.

There was a comment that a multiplier of the average length of line could be used. However, we already have number of sets, and they should not be double counted. It might be useful for tracking space occupied over time, which is still captured by number of sets.

It was stated that there is not yet a finalized habitat map. The intent was to track seabed impacts by habitat type and that component should not be lost.

There was a question as to whether there is any mitigation to protect whales and if the longliners can bait with squid. There is mitigation. It was said that whales do not take hooks, they run into line, but that is not exactly true. Depredation has been reported off Newfoundland with northern bottlenose whales and pilot whales, and sperm whales can be a problem for pelagic longlines.

For Indicator 34 there was a question as to whether results were compared to VMS. VMS was the source of the false positives, and tracking the false positives is not desired. Reports may be tracked if there is suspicion of illegal fishing, though with little fishing this might not be a big deal.

For Indicator 35 the intent was to report only what could be measured on deck. Longlines bring up coral.

There was a comment that incidents are to be documented, so there could be two sub-indicators: number of incidents and amounts removed.

The idea of 100 percent observer coverage for the Gully MPA was raised, recognizing that DFO would probably have to pay for it and it would still represent a burden to industry. The objective associated with this would have to be clearly described (to improve information on the location of fishing or for bycatch reporting purposes). DFO would not be paying for one third of the costs for standard fisheries coverage but can still pay for extra coverage.

For Indicator 40 there was a question as to what the metric was. It was not meant to be a numeric indicator, more as context. A way to track amount of seismic noise is needed. A seismic line close to the Gully MPA would be more important than one further away.

It was strongly suggested that the proposed 50 km buffer was somewhat arbitrary and may not be appropriate given that other threats were evaluated at other scales (e.g., fisheries to 10 NM). This buffer was simply based on the recommendation of voluntary avoidance of the Gully MPA of 50 km.

There was a statement that it is useful to know that there is a call for bids, but it might be more useful to know the results of the call for bids. There was a question as to whether people actually bid on these and if they could point to the website so the links would always be up to date. The Newfoundland calls for bids (e.g., ones just on the other side of the line) are not shown. There was a question as to activity in the French zone.

For Indicator 41 there was a question about whether produced water is included. Condensate includes what is above 44 mg/L (the intended limit). If the system is working, this should not

impact the Gully. However, there is a question as to whether only spills should be monitored. Currently, there is no produced water discharged within 50 km of the MPA. Oil in water does have impact on larvae, but it is unknown whether that impacts the Gully.

Ongoing produced water discharges are not public but they are tracked by the CNSOPB. They are the largest amount of oil discharged, so technically they should be tracked.

Oil-based muds are shipped to shore but water-based muds are discharged. Water-based muds no longer use barite; they use salt water for weighting, but it is still a discharge.

For Indicator 30, it was asked whether there was an intent to fine ships that travel through the Gully. It was stated that this could not be controlled as it was not included in the Gully regulations (though it was perhaps in Canadian legal jurisdiction). An application could be made to introduce a voluntary measure that might be respected. A question was asked as to whether real-time data could be recorded. The response was that this would not be easy, but if you knew who they were, they could be talked to. This is not the same as with ballast.

There was a discussion about shipping routes. There are two shipping routes: North/South ones coming from the Gulf of St. Lawrence and the Great Circle route, but they probably do not know an MPA is there. It was suggested that the Russian charts could be examined to see if the MPA is there. Though it might actually be on many of the charts as a polygon, there was a question as to whether the notice to mariners that calls for the avoidance of the MPA has been translated.

For Indicator 42 there was a question about whether there were fines. It was stated that it is hard to prosecute, but they are hoping for administrative monetary penalties (fines). Many are first time offenders.

There was a statement about the dumping being in the topmost waters. This only matters if it results in the introduction of invasive species. Invasive tunicates have been seen on Georges Bank, and phytoplankton have been detected on the Scotian Shelf. Invasive species are not an easy thing to work up. It was stated that some thought should be given as to whether it should be part of the ecosystem monitoring package. It is most important that we capture invasive species that get established in the Gully itself.

For Indicator 43, a question as to whether ISTOP (Integrated Satellite Tracking of Pollution) was included was asked. ISTOP is fed into the database, and it is used to plan flights. It is funded by Health of the Oceans. There was a statement about being consistent in reporting oily discharges: that it should be the same for all sources.

There was a recommendation to make buffers for oil from all sources the same, although seismic noise might be different.

With regards to discharge, it is too hard to track lost containers. But there are reports of garbage discharge, and it cannot be said that illegal discharge does not occur.

Indicator 46 was not reviewed. As recommended in the Gully MPA framework, researchers could be asked to report whether they saw anything.

There are indicators that are connected, such as noisy activities and the impacts of noise. It should be ensured that these are connected in the reporting process. Eliminating one without the other should be avoided.

Canada has made a commitment on integrated management. ESSIM was discontinued and there is more focus on MPAs and networks. There is a desire for the indicators to be good for the Gully, but there is concern that network objectives will also have to be considered. There was a hope that there would be both regional as well as Gully-specific indicators.

There is a lot of consistency between the Gully and Musquash monitoring plans.

The issues are similar (e.g., maintaining consistency over time if you want to analyze trends). In trend monitoring, species- and size-selective surveys are not a problem as long as the selectivity's are consistent from year to year. Support for J. Choi's approach of looking at community composition and multivariate analysis was expressed. It was suggested that diversity indices would not change much, so they may be good for reporting, but they do not tell you much about what is happening. There was a caution that they should not be abused; it should not be assumed that the sampling is adequate (at the asymptote of the species accumulation curve).

CONCLUDING DISCUSSION

It was stated that the Working Papers reviewed were very valuable and should be published as sections of a single Research Document.

Development of a monitoring plan for the MPA, building on the material from the workshop, is an important next step.

In the absence of a dedicated MPA monitoring program (possibly implying a dedicated series of annual cruises), monitoring of the Gully MPA will likely need to build on existing programs (e.g., AZMP) by adapting and adding to them.

It was noted that the bulk of the cetacean monitoring program currently resides outside of the government, and MPA monitoring is going to require working with partners.

Groundfish monitoring needs more work, as currently we do not have a good handle on the whole community. However, it might be more important to fill gaps in our understanding of the mesopelagic community. There are regional groundfish surveys that are conducted that do already tell us something about what is going on there. Increased observer coverage on the commercial index may be another option to consider, though presence of observers may change fishing behaviour.

There was a question about the usefulness of the RV survey as a platform for monitoring the Gully MPA. As trawling is not currently permitted near coral (Zones 1 or 2), and if the standard stratified-random sets were relied upon, spatial variance may be an issue. The proposed monitoring framework suggests adding fixed stations in Zone 3, on either side of the Gully. However, only shallow-dwelling, bank-top species may be sampled in this way.

The usefulness of trap surveys for monitoring of the Gully MPA was discussed. A typical crab boat could likely winch only one trap at a time. In deep water, that is 1000 m of line per trap, either individual buoy lines or floating groundlines. This is not practical, and a lot of line floating in the Gully is not desirable.

A statement was made that moored acoustics are not a proven technology and need to be well calibrated.

The role of acoustic monitoring versus collection of baseline data was discussed. It was suggested that there should be a high priority on collecting baseline acoustic information and then on repeating these measurements in 10 years but perhaps less priority on continuous acoustic monitoring. It was considered necessary to collect baseline data on both the acoustic environment (noise) and on use of the Gully by cetaceans. It was considered worthwhile to make efforts to compare use of the Gully MPA with and without the presence of seismic noise. It would be useful to have equipment that could be deployed when a noise event, such as a seismic survey, was going to occur within close proximity to the Gully MPA.

There was a review of the cetacean indicators that concluded that abundance was of the highest priority and the others of lower priority. It was suggested that monitoring of genetic diversity may not be a high priority at present. The idea of event-driven contaminant studies was discussed. It was suggested that if biopsies were being collected for analysis of contaminants, they should also be used for analysis of genetics at the same time to make full use of the samples that are collected.

When looking at abundance of other cetaceans, there should be a comparison to regional information. Information is collected in the bird surveys (year round). There is a spike in the spring and summer, but at least they are done in more months. It was suggested that this could be used to look at interactions between seabirds and cetaceans. Multispecies foraging assemblages could be identified. Effort would be needed to characterize the Gully community and Sowerby's beaked whales as well. There was a comment that since there is virtually no cost to look at other whales, it should be done also.

Water movement work has helped to inform our understanding of the Gully, but it is not an indicator and more research could be done.

If there is interest in pH, there could be a simple mooring placed on the bottom to which a CTD could be attached; however, this was not considered a priority at this time. There was a question about tracking the NAO (North Atlantic Oscillation) and the response was "only in the 100–300m depth range." Meteorology is reported in the AZMP; it is always an option for such information (temperature and salinity) in the Gully. Stations within the Gully can confirm this information.

There was a question as to the necessity of doing the Gully AZMP station. Ten years of data are used to model the relationship between the Halifax line and the Gully, so there is value in having that station until we know more. Doing depth-stratified tows for plankton shows euphausiids have a patchy distribution, and while only doing the one station, other plankton is obtained. There was a request for the data to be analyzed to determine whether additional stations are needed. It was recommend that the AZMP stations be continued until it is shown that they are not needed.

It was pointed out that the station is on the canyon wall, so a deeper station might be useful. It was stated that mooring problems are not so bad on the canyon walls (acoustics) – GULD 3. This could determine variability.

It was noted that oxygen had not been discussed, and that it is a good indicator of source water.

For seabirds, it was stated that every ship that goes to the Gully should be encouraged to record seabirds.

There was a question about whether to spend the money to analyze the coral size information.

It was noted that benthic characterization is still needed.

There was a suggestion that fisheries catch just outside the Gully might be an interesting source of information to help characterize inside the Gully; lots of sea cucumber and snow crab are seen there. It was suggested that either effort or catch should be selected and to use catches if they are georeferenced.

APPENDIX 1. LIST OF PARTICIPANTS

NAME	Affiliation
Allard, Karel	Environment Canada, Canadian Wildlife Service
Anderson, George	Transport Canada
Brilliant, Sean	Canadian Wildlife Federation (CWF)
Choi, Jae	DFO Maritimes / Population Ecology Division
Claytor, Ross	DFO Maritimes / Population Ecology Division
Clement, Pierre	DFO Maritimes / Coastal Ecosystem Science
Cochrane, Norman	DFO Maritimes / Oceans & Ecosystem Science
Cook-Ohyrn, Candice	Shell Canada
Cooper, Andrew	DFO Maritimes / SABS
de Santo, Elizabeth	Dalhousie University / Biology
Dunn, David	APCFNC Secretariat
Eagles, Mike	DFO Maritimes / Resource Mgmt.
Fenton, Derek	DFO Maritimes / Oceans & Coastal Mgmt.
Floyd, Trevor	DFO Maritimes / Centre for Science Advice
Fuller, Susanna	Ecology Action Centre (EAC)
Gjerdrum, Carina	Environment Canada, Canadian Wildlife Service
Gomez, Catalina	DFO Maritimes / Population Ecology Division
Greenan, Blair	DFO Maritimes / Oceans & Ecosystem Science
Head, Erica	DFO Maritimes / Oceans & Ecosystem Science
Hellou, Jocelyne	DFO Maritimes / Coastal Ecosystem Science
Hurley, Geoff	Hurley Environment Ltd.
Jayawardane, Aruna	Maliseet Nation Conservation Council (MNCC)
Kenchington, Trevor	Gadus Associates
Kennedy, Eddy	DFO Maritimes / Coastal Ecosystem Science
Koropatnick, Tanya	DFO Maritimes / Oceans & Coastal Mgmt
MacDonald, Claire	DFO Maritimes / Resource Mgmt.
MacDonald, Elizabeth	Canada-NS Offshore Petroleum Board (CNSOPB)
Macnab, Paul	DFO Maritimes / Oceans & Coastal Mgmt.
McNeely, Joshua	IKANAWTIKET, Maritime Aboriginal Peoples Council (MAPC)
Miller, Chris	Canadian Parks and Wilderness Society (CPAWS-NS)
Moors, Hilary	DFO Maritimes / Oceans & Ecosystem Science
Peters, Gerard	DFO Maritimes / Resource Mgmt.
Salsbury, John	Seafood Producers Association of Nova Scotia (SPANS)
Shervill, Dan	DFO Maritimes / Oceans & Coastal Mgmt
Spears, Tobias	DFO Maritimes / Ecosystems & Oceans Science
Thillet, Marielle	Encana Corporation
Trzcinski, Kurtis	DFO Maritimes / Population Ecology Division
Ure, Darien	Parks Canada / Mainland NS
Westhead, Maxine	DFO Maritimes / Oceans & Coastal Mgmt
Whitehead, Hal	Dalhousie University / Biology
Worcester, Tana (Chair)	DFO Maritimes / Centre for Science Advice

APPENDIX 2. TERMS OF REFERENCE

Review of Existing Data, Protocols, and Procedures for the Gully Marine Protected Area Ecosystem Monitoring Plan

Regional Peer Review – Maritimes Region

September 25–26, 2012

Bedford Institute of Oceanography (Lewis King Boardroom)
Dartmouth, Nova Scotia
Chairperson: Tana Worcester

Context

The Gully is the largest marine canyon in eastern North America. Located offshore Nova Scotia near Sable Island, the Gully contains a rich diversity of marine habitats and species, including deep-sea corals and northern bottlenose whales. The area is nationally and globally acknowledged as a unique and important marine habitat. The Gully was designated as a Marine Protected Area (MPA) under the *Oceans Act* in May 2004. Management of the Gully MPA is conducted in accordance with the *Gully Marine Protected Area Regulations* and *The Gully Marine Protected Area Management Plan*.

Within the Plan, the conservation objectives for the Gully MPA are to:

- Protect the health and integrity of the Gully ecosystem:
- Protect the natural biodiversity of the Gully
- Protect the physical structure of the Gully and its physical and chemical properties
- Maintain the productivity of the Gully ecosystem

In support of the Health of the Oceans Initiative, DFO Science developed an Ecosystem Monitoring Framework to address the conservation objectives for the Gully MPA, consisting of a suite of 47 indicators, and advice on how to implement a cost-effective monitoring program that incorporates existing monitoring programs, protocols and strategies to the extent possible. A Maritimes Region Science Advisory Process was conducted in February 2010 to review the indicators, protocols, and strategies developed for monitoring of the Gully MPA (DFO 2010; Kenchington 2010).

Research and monitoring activities have been conducted in the Gully since the mid-1900s, and data exists that could contribute to 34 of the 47 indicators listed in the Ecosystem Monitoring Framework. However, to date, little has been done to evaluate the available data to determine if the Gully MPA is achieving the conservation objectives laid out in the management plan. Further, the Science Advisory Report on the Gully Monitoring Framework identified the need to develop standardized monitoring protocols so that data collection and analyses are consistent over the long term.

The proposed meeting would provide an evaluation of existing data that could inform indicators to be included in a Gully Ecosystem Monitoring Plan, and also provide a review of existing protocols and procedures to determine if changes are required to meet MPA monitoring needs.

Objectives

The objectives of this meeting are:

- To provide a scientific peer review of available data for selected indicators identified in the Gully Ecosystem Monitoring Framework to determine the state of the Gully ecosystem.

- To provide recommendations regarding the appropriateness of available data and monitoring programs, protocols, and procedures to evaluate the effectiveness of the indicators identified in the Gully Ecosystem Monitoring Framework, and, based on this, recommend indicators that should be continued.
- To provide recommendations on protocol development or changes to existing monitoring protocols and strategies needed to effectively meet MPA monitoring needs.
- To provide recommendations on possible approaches to reporting on the state of the Gully ecosystem using these indicators.

Expected Publications

- Proceedings
- Research Document(s)

Participation

- DFO Science
- DFO Ecosystem Management
- Environment Canada
- CNSOPB
- Nova Scotia Provincial Representatives
- Aboriginal communities / organizations
- Offshore Oil & Gas Industry
- Non-Government Organizations
- Fishing Industry
- Academics

References

DFO. 2010. Review of the Gully Marine Protected Area Monitoring Indicators, Protocols and Strategies. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2010/066.

Kenchington, T. 2010. Environmental Monitoring of the Gully Marine Protected Area: A Recommendation. Can. Sci. Advis. Sec. Res. Doc. 2010/075.

APPENDIX 3. AGENDA

25 September 2012 – Tuesday

9:00–9:30 Introduction

9:30–10:00 Summary of Gully MPA Monitoring Framework (T. Kenchington)

10:00–11:00 Review of Existing Data and Monitoring Protocols:

- Living Resources (K. Trzcinski, T. Kenchington)

11:00–11:15 Break

11:15–12:00 Review of Existing Data and Monitoring Protocols (con.):

- Seafloor Habitat (T. Kenchington)

12:00–1:00 Lunch (not provided)

1:00–2:30 Review of Existing Data and Monitoring Protocols (con.):

- Water and Sediment Quality (B. Greenan, E. Head)
- Birds (C. Gjerdrum)

2:30–2:45 Break

2:45–5:00 Review of Existing Data and Monitoring Protocols (con.):

- Cetaceans (H. Whitehead / H. Moors)
- Acoustics (H. Moors / N. Cochrane)
- Indicators to Monitor Pressures (T. Koropatnick)

26 September 2012 – Wednesday

9:00–9:30 Summary of Day One

9:30–10:00 Approach to reporting on indicators in the snow crab assessment (J. Choi).

10:00–10:30 Discussion: Recommendations for reporting on the state of the Gully MPA ecosystem.

10:30–10:45 Break

10:45–12:00 Discussion: Recommendations on the appropriateness of existing data to report on the state of the Gully MPA ecosystem.

12:00–1:00 Lunch (not provided)

1:00–end Discussion: Recommendations on any changes required to monitoring protocols and procedures for the Gully MPA.

APPENDIX 4. SUMMARY OF DAY ONE

Day One began with an overview of the 2010 Monitoring Framework. This provoked some questions about what the goal of the monitoring was meant to be, with several goals discussed: 1) to provide baseline information and context for future potential impacts, 2) to be able to detect early warning signals that something might be changing, 3) to answer the question “are we achieving our conservation objectives,” and 4) to inform potential changes in management. It needs to be clear that we are looking for indicators that managers can respond to in the short term, as well as indicators that inform a longer-term understanding of processes and changes within the Gully. There were some questions about what the next steps would be for the indicators that were not analyzed for this meeting.

Next, presentations were given on indicators that addressed the conservation priority, “Conserve commercial and non-commercial living resources.”

K. Trzcinski provided an analysis of the usefulness of the halibut fixed station survey and commercial index for Gully MPA monitoring purposes (Indicator 18). Species richness and diversity indices were calculated, but there is no trend in the time series so far. Some information could be extracted on a few groundfish species, such as halibut, cusk, white hake and northern wolffish. Given that these are commercial species and species at risk (or on the COSEWIC list), we do care about these species but at the same time, we do not want to impact species at risk with a survey (more important to protect or monitor?). We were asked to consider whether, using this survey, we could answer the question “Are you achieving your conservation objective?” which in this case means “Are you conserving the commercial and non-commercial resources of the Gully MPA?” or “Are you protecting the natural biodiversity of the Gully MPA?” The role of bait and hook size on species composition caught by this survey and whether there might be other approaches to monitoring this component of the ecosystem were discussed. Would expanding the geographic scale of monitoring for this indicator increase its information content while still being meaningful for the Gully or would it be more meaningful to compare results with other canyons. Based on this discussion, T. Kenchington suggested that there were at least four options available: 1) forget the halibut survey; 2) while it is being done for fishery purposes, continue to use the data as part of the MPA monitoring program but do not ask for changes to the surveys; 3) ensure that Station 85 is added to the list of core stations (so that it will be occupied every year) and incorporate the survey into the MPA monitoring program, such that the implications for MPA management will be considered before the surveys are modified or terminated; and 4) add more fixed stations within the MPA and/or require observers on the commercial index, thus upgrading the quality and quantity of data relevant to MPA monitoring from the surveys.

Next, T. Kenchington talked about the mesopelagic survey (Indicator 20), which has caught approximately 300 fish species, plus crustaceans, squids and some others. For monitoring purposes, a focus on two species, *Benthosema glaciale* (myctophid fish) and *Meganyctiphanes norvegica* (krill), was recommended. These are dominant species and presumably important for the Gully. They could also be important in increasing our understanding of mesopelagic communities, which we know little about in general (benefits beyond the MPA). However, the survey gear does not adequately sample the key squid species (*Gonatus*) that we are interested in for northern bottlenose whale feeding. Different sampling methods (visual) were discussed, as were ways of pinpointing where the squid might be (using northern bottlenose whale diving patterns). Everyone seemed to agree that a better understanding of the distribution of northern bottlenose whale prey remains an important gap—highlighting how we cannot monitor what we do not understand.

Indicators 17 (trawl survey) and 19 (trap survey) were not presented at this time, but these would be discussed on Day Two.

Then, indicators intended to address the conservation priority, “Protecting the seafloor habitat and associated benthic communities,” were presented.

T. Kenchington described the baseline survey that was done for corals (Indicators 13–16). This survey was not to be done again until 2017, so while there is information on species richness, there is no trend information. Size information would be available at a cost. There was no zooanthid overgrowth or debris observed on the one established monitoring station. Discussion focused on possible risks to coral, including pH, which was discussed again after presentations by E. Head and B. Greenan. There were some questions about whether the survey provided information on other species – likely nothing that useful. More discussion of corals may be needed – perhaps as technology evolves.

Then, indicators that were classified under the conservation priority, “Maintain or restore the quality of the water and sediments of the Gully,” were presented.

B. Greenan gave a presentation, but a working paper was not available for the meeting. Indicator 25 is intended to generate summaries of the physical and chemical data in terms that have some ecological meaning (water types and their movements) rather than just as anomaly plots. This indicator is currently at the baseline research stage rather than the indicator reporting stage. Very strong currents (70 cm/s) were found, with average water flow above the rim moving to the southwest. There was also evidence of below rim eddy/rotation, which could enhance retention. Average flow is towards the north below the rim. There is a small amount of upwelling. There is a bottom-intensified K1 current and an unusual interaction between K1 and M2 currents. The data support the view that the Gully is a unique physical feature. High flows could explain presence of corals. A hypothesis was proposed for movement of energy through the system – moving of nutrients from the banks down to the seafloor. A computer model of water movement is being developed with Dalhousie University.

E. Head reported on the protocols used by AZMP to sample temperature, salinity, oxygen, light, chlorophyll pigments and nutrients (Indicators 21–22) both within the Gully MPA (one station inside the canyon and three across the mouth) and along the Halifax and Louisbourg lines. These data are analyzed annually for the Halifax and Louisbourg lines, and could be reported as indicators for the Gully MPA. She showed the nitrate profiles and the average 0-50 m nitrates in spring and fall from the lines. She mentioned the increasing trend in SST over time. Alkalinity and pH were not measured, though there is now a pH meter on the CTD. Information has not been specifically collated for the Gully stations specifically. She suggested that satellite imagery is better for reporting on chlorophyll (within standard areas, every two weeks) The Eastern Scotian Shelf is of relevance to the Gully MPA. B. Greenan mentioned that only SST and ocean colour are consistently reported from satellite data.

Indicator 24 was not discussed (meteorological data from on Sable Island and weather buoys).

For Indicator 26, reporting of phytoplankton production as a satellite interpreted product is not yet available. As techniques for estimating composition from satellite observation of pigments are brought to a workable state, they should be applied to the data from the Gully. The timing of the spring and fall blooms can be interpreted from the data (e.g., there was an earlier and more intense spring bloom in 2010 and 2012).

For Indicator 27, zooplankton biomass is reported but not community composition. A Shannon-Wiener index could be done if desired. All data on *Calanus* from the Gully was collated. It shows a pattern consistent with the life-cycle of *Calanus* which means it is important what time of year you sample.

N. Cochrane talked about acoustic scattering as a means to investigate mesopelagic and zooplankton communities (Indicator 28). He did not present results of work to date, but he did provide some recommendations on how work could be conducted in the future. The importance of calibration and maintaining expertise, using multiple frequencies to better distinguish krill from fish and more frequencies allowing for better distinction of populations were mentioned. It was suggested that two moored echo sounders could provide better temporal coverage (though this does not address the issue of spatial coverage). Concerns were expressed by some participants on the impacts of long-term pinging (source of noise) and moorings. For spatial coverage, we would need the CCGS *Hudson*'s replacement to consider acoustic monitoring as part of the design or make use of mesopelagic survey platform, should it be continued.

C. Gjerdrum provided an overview of information available for seabirds in the Gully MPA (Indicator 29). There is less information from PIROP than expected on this area. Even with modern data, we are not capturing seasonal variation, rare species or temporal trends. However, we can quantify seabird density and distribution over a broader area. A baseline is still being established. Even with these issues, Gully stands out as an important area for seabirds, particularly deep diving birds (alcids), though these are not the most common species found in the Gully. It would be useful to further explore the physical and biological features to explain use of the Gully by seabirds. This is hard to explain given current information on waters above rim depth and daylight plankton/fish communities available for birds to feed on. There must be an impact of the canyon feature on depths that the seabirds can reach, perhaps through interactions with cetaceans or other behaviours / mechanisms that we are not currently capturing.

At the end of the day, indicators were presented that were meant to inform the conservation priority "Protecting cetaceans from impacts caused by humans."

H. Whitehead talked about the work that has been done to evaluate the abundance of the Scotian Shelf population of northern bottlenose whales (Indicator 1). Current closed-population estimate is 143 (127–158) with no apparent trend. Indicators 2–4 are discussed in the working paper; scars on cetaceans have not yet been examined in detail. Indicator 5 has been discussed previously and there is no point in looking at genetic diversity again for another 10 years. Indicator 6 has also been discussed previously, although contaminants could be looked at in another couple of years. There some interesting results to not for Indicator 7 "Abundance of other cetaceans in the Gully." There was a significant increase in the abundance of Sowerby's beaked whales in the general area with a preference for the Shortland and Haldimand canyons over the Gully. There were also increases in blue whales and pilot whales. There were decreases in fin whales, humpback whales, white-sided dolphins and striped dolphins. Reasons for changes in numbers recorded might be changes in population size or changes in distribution, possibly related to changes in food supply or disturbance regime. There was some speculation about whether the Gully MPA is less noisy than in the past. There was a suggestion to consider pod size in the analyses (are the pods smaller but more numerous?).

H. Moors talked about using passive acoustics to monitor northern bottlenose whale presence and activity in the Gully (Indicator 8); there are more than 3100 hours of recordings. There is no difference between summer and winter presence, but there was differential use of areas within the Gully. There was more vocal activity at night than during the day, but this is not observed with tagging data. These whales also use of the slope between the canyons. In order to investigate other species, we need to develop automated detection and determine the effective reporting range for each system. It was clarified that this is not real-time reporting. There were discussions about the pros and cons of pop-ups versus AMARs as well as the use of platforms for cetacean observations on tourism vessels and the DND sail training vessel. Current

monitoring proposals are dependent on H. Whitehead of Dalhousie University and fortunately, he is not planning to retire soon.

APPENDIX 5. SUMMARY OF DAY TWO

Day Two began with a summary of the proceedings from Day One presented by T. Worcester. To facilitate discussion on one of the workshop objectives, "To provide recommendations on possible approaches to reporting on the state of the Gully ecosystem using these indicators," J. Choi talked about how he reports on a series of indicators for the snow crab assessment. He started out by describing how we normally tackle understanding large systems: we create a simple model from what we think we understand. However, there are large 'middle number systems' for which we cannot measure everything in them but that lack a central principle. Humans have an upper limit on the amount of information they can process, integrate and understand and the information content of real ecosystems greatly surpasses this upper limit, so we need to simplify things using other approaches.

We can use multivariate analysis (ordination) to compress information (50 indicators) into something more manageable (2 dimensions). In the snow crab assessment, 60 metrics were identified: environmental factors, fish abundance, fisheries metrics, economic metrics, landings and so on. Metrics were scored according to their standard deviation, and no value was associated with being just above or below the mean. The 1st Principal Component of the correlation matrix explained 17% of the variation, showing change over time. A red/green map allows you to identify visually where the coherence occurs which helps in explaining to fishers what is going on in the environment. He suggested that a more traditional approach can also be used: multispecies ordination. A graphic representation (map) of the ordination provides a sense of the community composition. The first axis is temperature related and the second axis is depth related.

There was a discussion after J. Choi's presentation which brought up a number of questions about how the method could be used for the Gully MPA. In terms of which indicators and which data could be used, species or subsets of taxa could be looked at and a hierarchical nest of species or species groups could be used, even when data have different sampling frequencies. This means all indicators can be looked at together or just pressure indicators, and they can be weighted differently if there is reason to do so. There was a suggestion that an elaborate multivariate analysis that is still descriptive could be used where quantitative methods could be used to determine number of states (analysis of variance) to help determine when they go outside the bounds of natural variability. There are enough data for the Gully MPA to do that kind of analysis, although holes will need to be filled and some assumptions must be made.

There was a comment on the human aspect of using such a model and that humans will need to pick out the important individual indicators. There is a need to make a choice between putting our faith in the numbers or in the people who are interpreting the numbers. For example, correlations between variables (e.g., temperature) must be taken into account to ensure the model is not self-predictive. Not only must the correlation between the variables be understood, but there also needs to be agreement on what needs to be measured—not just using what we have. Making things transparent and communicating the key message to managers is what is ultimately useful. The choice of indicators is important, and if the indicators are unbalanced, a hierarchical approach can be used, or they can be trimmed. The process is an iterative one. A question was raised about whether the analysis should be done at the large scale so the different MPAs can be examined. Variables that are useful across the region could be picked, and then metrics that are also useful for the Gully MPA could be added. The work needs to be able to be replicated in time and explained as more MPAs coming online.

N. Cochrane presented his paper on anthropogenic sound in the Gully MPA (Indicator 47).

The basics of noise in the marine environment were presented. Ships are the major contributor to anthropogenic noise in the marine environment, and there is no ongoing program for

monitoring acoustics. Recordings were conducted by DFO in the Gully MPA in 2003, 2005, 2006, 2010 and 2011 at over 1000 m depth for usually less than 25 days. OBSs and AMARs were used, but it would be useful to purchase another AMAR unit to place in the Gully along with the others being placed along the Slope. Existing datasets are too short and discontinuous to adequately characterize the noise variability. OBSs have a 2 kHz cutoff, which cuts off the toothed-whale characterizations and hydrophones too close to the bottom limit dynamic range. Recommendations were made for the following: long-term deployments, near-continuous coverage, noise recording to >30 kHz, low noise omnidirectional hydrophones, primary data collection near 1500 m depth contour, additional data gathering in top 100 m (in a shallower area of the Gully) and gathering of ancillary data for correlation (sea state, wind, precipitation and vessel traffic).

The discussion following N. Cochrane's presentation focused on partnerships and equipment. A proposal for a big acoustic program with DRDC in 2011 did not go through, but DRDC did do some work on noise in the Gully (Desharnais and Collison used sonobuoys to look at the upper layer). SARA will probably use the AMAR later to assess other species outside the Gully; it would be nice to have one for the Gully (or MPAs in general). Ideally, four systems would be deployed, but it will depend on funding. It would be impossible to do continuous monitoring with only one, and it is possible that the department could lose one.

T. Koropatnick presented information for Indicators 30 through 44. Indicator 46 was not presented. For Indicators 32 and 33, commercial demersal and pelagic longline fishing effort within and in close proximity to the MPA (10 NM buffer), data were taken from MARFIS in 1-minute grid cells. There was an increasing trend in demersal fishing effort (most in 2011) which is related to increasing the halibut quota. Pelagic effort was mostly outside the MPA. There was no trend in quantities of organisms removed by fishing in close proximity to the MPA (Indicators 35 and 37), but there were changes in catch versus effort. For Indicator 36, at-sea observer data and MARFIS data were used. The targeted species are halibut, swordfish and tuna. The top three bycatch species were cusk, white hake and cod. Discards (from 12 observed trips) were sharks, skates and wolffish. There is a need for better observer coverage in the Gully. The idea of 100 percent observer coverage for the Gully MPA was raised, recognizing that DFO would probably have to pay for it and it would still represent a burden to industry. The objective associated with this would have to be clearly described (to improve information on the location of fishing or for bycatch reporting purposes).

Indicators 38 and 39 were combined, though there was disagreement over this. From 2005 to 2011, 17% of fishable cells were fished. This is variable over time and there was an increase in 2011. There were five incidents of unauthorized fishing in the MPA (Indicator 34) since 2004. No coral bycatch was reported from fisheries (Indicator 35), but there was some research activity during which a canyon wall was bumped.

For Indicator 40, offshore petroleum exploration and development activities, data from 1999 to 2003 were analyzed and showed three wells within the 50 km of the MPA. There was no trend in the number, quantities and type of discharges from offshore petroleum on the ESS (Indicator 41) and results are driven by a small number of spills. For Indicator 30, vessel transits from February 2010 to February 2011 were analyzed from LRIT 6-hourly position reports produced by the Canadian Coast Guard. In total, 497 tracks in 13 months were analyzed, averaging 38 transits per month. There was no obvious seasonal trend. Breaking down the data by vessel type and speed would also be beneficial. VMS was used for fishing vessels; vessels that were fishing were filtered out. Numbers were relatively constant through time; from 2008 to 2010 there were more fishing vessels than transiting.

For Indicator 42, ballast water, there are alternative ballast water exchange zones (ABWEZ); one of which is close to the Gully (5 km). There were 6 exchanges in 2007, 11 in 2008 and 17 in 2009. Track lines are inferred paths, so Gully avoidance is not captured in the dataset. The water quality of water in exchanges in the MPA is unknown, although it is likely that it was at the end stages of exchange. For Indicator 43, oil discharges, there is a national aerial surveillance program. In 2011, 31 flights passed near the MPA. There were no detections within 100 km of the MPA from April 2007 to Dec 2011. For floating debris (Indicator 44), a visual transect for large debris and a neuston net tow for small debris took place in the summer of 2008. Results showed there were 31.6 items/km^2 more inside the Gully than outside. Indicator 46, on aquatic invasive species, was not reviewed. As recommended in the Gully MPA framework, researchers could be asked to report if they see anything.

Overall for the threats indicators, a lot of information concerning the Gully was extracted from regional or zonal monitoring. Some attendees thought that these indicators have only a very indirect relevance to the MPA and that it would be better to monitor more directly (e.g., look at underwater sound rather than ship transits).

There was a general discussion on the indicators for the Gully MPA and how Canada has made a commitment on integrated management. ESSIM was discontinued, so there is more focus on MPAs and networks. There is a desire for the indicators to be good for the Gully, but there is concern that network objectives will also have to be considered. There was a hope that there would be both regional as well as Gully-specific indicators. Another point was that many indicators are connected, such as noisy activities and the impacts of noise, and we should ensure that they remain connected in the reporting process. Eliminating one without the other should be avoided. There is a lot of consistency between the Gully and Musquash monitoring plans: the issues are similar (e.g., maintaining consistency over time if you want to analyze trends). In trend monitoring, species- and size-selective surveys are not a problem as long as the selectivities are consistent from year to year. Support for J. Choi's approach of looking at community composition and multivariate analysis was expressed. It was suggested that diversity indices would not change much, so they may also be good for reporting.

In the concluding discussion, many of the above indicators were broadly revisited.

- Groundfish monitoring needs more work; there is a fishery for it, so improvements need to be made. Currently we do not have a good handle on the whole community so K. Trzcinski suggested that it might be more important to understand the mesopelagic community. Increased observer coverage on the commercial index may be another option to consider.
- The usefulness of the RV survey was questioned since the RV survey would not be as informative.
- The trap survey was T. Kenchington's proposal, and he is doubtful of its viability. A typical crab boat could likely winch only one trap at a time. In deep water, that is 1000 m of line per trap, either individual buoy lines or floating groundlines. This is not practical and a lot of line floating in the Gully is not desirable.
- The role of acoustic monitoring versus collection of baseline data was discussed. It was suggested that there should be a high priority on collecting baseline acoustic information and then on repeating these measurements in 10 years but perhaps less priority on continuous acoustic monitoring. It was considered necessary to get baseline data on both the acoustic environment (noise) and on use of the Gully by cetaceans.
- A review of the cetacean indicators concluded that abundance was of the highest priority and the others of lower priority. When looking at abundance of other cetaceans, there should be a comparison to regional information. Information is collected in the bird surveys

(year round). It was suggested that this could be used to look at interactions between seabirds and cetaceans. It was noted that the bulk of the cetacean program resides outside of the government. MPA monitoring is going to require working with partners.

- The necessity of doing the Gully AZMP station was questioned. Ten years of data are used to model the relationship between the Halifax line and the Gully, so there is value in having that station until we know more. It was recommend that the AZMP stations be continued until it is shown that they are not needed.
- A common theme emerged during this meeting related to the lack of funding, resources and expertise. Ships and basic infrastructure are also required.

It was agreed upon that the Working Papers reviewed were very valuable and should be published as sections of a single Research Document. Development of a monitoring plan for the MPA, building on the material from the workshop, was identified as a task for OCMD. A dedicated MPA monitoring program (possibly implying a dedicated series of annual cruises) is unlikely, so monitoring of the Gully MPA will need to build on existing programs (e.g., AZMP) by adapting and adding to them. All participants were thanked for their participation and the meeting was closed.

APPENDIX 6. ABBREVIATIONS

ABWEZ	Alternative Ballast Water Exchange Zones
ADCP	acoustic Doppler current profiler
AMAR	Autonomous Multi-Channel Acoustic Recorders
AZMP	Atlantic Zone Monitoring Program
BIO	Bedford Institute of Oceanography
BIONESS	Bedford Institute of Oceanography Net Environmental Sampling System
CCGS	Canadian Coast Guard Ship
CNSOPB	Canada-Nova Scotia Offshore Petroleum Board
COSEWIC	Committee on the Status of Endangered Wildlife in Canada
CPR	Continuous Plankton Recorder
CTD	conductivity, temperature, depth
DFO	Fisheries and Oceans Canada
DND	Department of National Defence
DRDC	Defence Research and Development Canada
ECSAS	Eastern Canada Seabirds at Sea
ESSIM	Eastern Scotian Shelf Integrated Management
ISTOP	Integrated Satellite Tracking of Pollution
IYGPT	International Young Gadoid Pelagic Trawl
JPA	joint project agreements
LADCP	Lowered Acoustic Doppler Current Profiler
LRIT	Long-Range Identification and Tracking
MARFIS	Maritime Fishery Information System
MPA	marine protected area
MSC	Marine Stewardship Council
NAO	North Atlantic Oscillation
OBS	ocean-bottom seismometer
OCMD	Oceans and Coastal Management Division
PCA	principal component analysis
PIROP	Programme intégré des recherches sur les oiseaux pélagiques
POM	particulate organic matter
ROPOS	Remotely Operated Platform for Ocean Sciences
RV	research vessel
SARA	*Species at Risk Act*
SST	sea surface temperature
VMS	Vessel Monitoring System