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Proceedings of the Regional Advisory Meeting on the Gully Marine Protected Area Monitoring: Review of Research Activities, Indicators, and Guidance on Next Steps

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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.

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SUMMARY

This five-day regional peer-review meeting was held from January 18-22, 2021. This meeting was conducted using Microsoft Teams, with the overall aims of reviewing the performance of the Gully Marine Protected Area in meeting its conservation objectives and providing advice on how to move forward efficiently with monitoring. Participants in this meeting included experts from both federal and provincial governments, Aboriginal communities/organizations, offshore petroleum industry, non-government organizations, the fishing industry, and academics. The meeting was structured with presentations followed by discussions. This report captures the general thrust of the discussions at the meeting. During the last day, participants focused on the content of the Science Advisory Report (SAR). At the end of the meeting, it was agreed that a follow-up meeting would be held to review the final version of the SAR. That session was held on October 14, 2021, and at which point the revised Science Advisory Report was reviewed and finalized.

INTRODUCTION

The Gully is the largest submarine canyon off eastern North America, supporting a rich diversity of habitats and species, including cold-water corals and deep-diving toothed whales. The area is acknowledged, nationally and globally, as a unique and important focus for conservation. Available scientific knowledge of the area was first drawn together by Harrison and Fenton (1998) and later updated by Gordon and Fenton (2002), following additional targeted research. In 2004, the Gully became Canada's first *Oceans Act* Marine Protected Area (MPA) to be designated in the Atlantic Ocean.

In 2008, a Management Plan was completed, providing support for the MPA regulations and guidance to Fisheries and Oceans Canada (DFO), other regulators and users on the protection and management of the MPA. Conservation objectives and sub-objectives specified in 2008 were maintained and recast as conservation goals for the second edition Management Plan (DFO 2017). The overarching goal for the Gully MPA is to protect the health and integrity of the Gully ecosystem. Sub-goals for the MPA are to:

- Protect the natural biodiversity of the Gully;
- Protect the physical structure of the Gully and its physical and chemical properties; and
- Maintain the productivity of the Gully ecosystem.

A framework for monitoring the MPA, including 47 proposed indicators, was prepared in 2010 to support the conservation goals and objectives (DFO 2010, Kenchington 2010). Available data, sampling protocols and monitoring programs supporting these indicators were later reviewed in 2012 (Allard et al. 2015). Monitoring and research has since continued in the MPA, helping to expand our understanding of the ecosystems, while also establishing baselines for future work and supporting improvements to the efficiency and efficacy of future monitoring.

A decade after the initial proposal of indicators, there is an opportunity and need to revisit the Gully monitoring program, to examine the utility of the data being gathered, identify gaps in coverage, incorporate new knowledge, document progress towards baselines from which change can be assessed, and interpret any observed trends. Centrally, this review seeks to evaluate whether the MPA is meeting its conservation objectives and to determine whether the current monitoring activities are suitable for this evaluation. The review will be instrumental to the formalization of a feasible monitoring program and practical implementation strategies for the Gully MPA.

As Atlantic Canada's first *Oceans Act* MPA, a peer review of the monitoring and assessment of the Gully is expected to provide important lessons and perspectives for the development of long-term monitoring programs at other offshore MPAs and ultimately for Canada's bioregional MPA networks.

OBJECTIVES

The objectives of this meeting were to review the performance of the Gully MPA in meeting its conservation objectives and to provide advice on how to move forward efficiently with monitoring. These objectives were to be accomplished through:

- scientific peer review of available data (and baselines where they have been developed) for each indicator listed in the Gully Monitoring Framework (Kenchington 2010) or for alternative indicators developed subsequently;
- the evaluation and interpretation of any trends from those indicators with reference to the MPA's conservation objectives;
- consideration of advances in understanding of the ecosystems in The Gully, including a conceptual model of those ecosystems, to provide a foundation for development of more efficient indicators and improved understanding of how the indicators reflect ecosystem function within the MPA;
- determination of which indicators are useful in the evaluation of MPA performance, leading to recommendations for improvements to the existing suite of indicators, including the addition or removal of indicators, as well as improvements or additions to monitoring protocols/strategies;
- the development of a minimal suite of indicators suitable for MPA performance evaluation and the identification of any gaps in the current monitoring program that should be prioritized for increased scientific effort;
- examination of linkages between ecological processes in the Gully and those of the broader Scotian Shelf MPA network planning region (e.g., through connectivity, gene flow, source-sink dynamics).

See Appendix A for the Terms of Reference. Participants in this meeting included, DFO Science, DFO Ecosystem Management, Environment and Climate Change Canada (ECCC), Natural Resources Canada (NRCan), the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB), Province of Nova Scotia, Aboriginal communities / organizations, offshore petroleum industry, non-government organizations, the fishing industry, and academics (see Appendix B for list of participants). This virtual meeting was held from the afternoon of January 18 to midday January 22, 2021 using Microsoft Teams (MS Teams) (see Appendix C for the Agenda). A follow-up meeting was held on October 14, 2021, to finalize the Science Advisory Report.

DAY 1: MONDAY, JANUARY 18TH

Rapporteurs: L. McConney and U. Goggin

The meeting started with the Chair, T. Worcester, welcoming everyone. Given the large number of participants, the Chair suggested that participants introduce themselves whenever they wanted to participate in the discussions. The Chair then went over the Canadian Science Advisory Secretariat (CSAS) peer review process and the use of the Scientific Advice for Government Effectiveness (SAGE) Principles and Guidelines. Since the meeting was using Microsoft Teams (MS Teams) as the platform, tips on the effective use of MS Teams were provided. The Terms of Reference and Agenda for the next four days were reviewed.

T. Kenchington presented an introduction and overview to the Gully MPA biodiversity and several possible explanations of energy flow in the Gully ecosystem. After the overview, there was a request to see the conservation objectives for the MPA and information on the management of human activities in the area. It was explained that the principal human activities

are marine transportation (shipping), commercial fisheries, and oil and gas activities. Pelagic longline is one of the key fishing gears deployed. When the MPA was designated, there were significant oil and gas exploration and development activities occurring on the Scotian Shelf. Presently, there is no oil and gas activities in the vicinity of the MPA. Research activities also occur in the area of the MPA.

The Gully MPA conservation objectives are:

- Minimize harmful impacts from human activities on cetacean populations and their habitats;
- Minimize the disturbance of seafloor habitat and associated benthic communities caused by human activities;
- Maintain and monitor the quality of water and sediments of the Gully; and
- Manage human activities to minimize impacts on other commercial and non-commercial living resources.

While whales and benthic ecosystems are important to the conservation objectives, the need to understand the processes that affect these biological components means that indicators of ecosystem function should also be monitored. There is a need to understand how and why environmental conditions (hydrography, plankton, etc.) are changing in order to interpret observed changes at higher trophic levels. As a result, monitoring regional trends is important to interpret the trends in the Gully indicators.

At the time of the MPA designation, there was suspicion that the discharge of drilling muds from oil and gas activities may end up in the Gully sediments; however, the decision was made not to monitor for this, and there is no ongoing sediment quality monitoring program.

INDICATORS #17–20 (FISH SURVEYS)

T. Kenchington next presented on the fish indicators for the Gully MPA. The existing data from five decades of groundfish-trawl surveys provide some descriptive information on the assemblage of demersal finfish present in the area in both spring and summer. There are some hints of temporal change in those data, though nothing can be discerned with certainty. Sampling at the Snow Crab survey stations within the MPA should be continued, as it appears potentially capable of detecting temporal change over periods longer than the five years. The data from halibut longlining indicate little detectable change in the ecosystem at the head of the canyon through the last 20 years. The halibut themselves appear to be stable or increasing. The 2010 framework proposed Midwater trawl monitoring to establish a quantitative baseline during 2007–09, but there has been no subsequent sampling to indicate temporal change.

The DFO Research Vessel (RV) surveys have found that the abundance of Atlantic Halibut is increasing across the Scotian Shelf and that redfish is increasing in management Unit 2, which includes the Gully.

The commercial fisheries permitted in and around the Gully MPA were briefly discussed. Demersal and pelagic longlining are permitted in Zones 2 and 3 the MPA. Most of the groundfish fisheries in the area around the MPA were either under a moratorium, cut-backs, or closures. The redfish fishery may still be going on to the east along the shelf edge and the Snow Crab fishery was occurring within 10 nautical miles of the MPA.

The benefits of the existing fisheries surveys to data collection were discussed. There was a question of how much Gully MPA-specific information is gained from the halibut longline survey since most of the individuals caught are large and mobile. The Snow Crab survey or the RV survey may provide additional information on small benthic species that would be more localized to the area. There has not been much RV survey sampling in the Gully MPA in recent years. It is usually left for the end of the survey period, and in some years the Gully station(s) get missed.

There was a discussion regarding the benefits of various survey designs. It was pointed out that a fixed station design may only tell what is going on in a specific location and may not provide an understanding of the Gully as a whole. Monitoring paired in/out stations are only useful if there are human activities outside (but not in the MPA) that might result in local-scale differences. On the other hand, a stratified-random survey that only places a few sets within the MPA, in any given year, cannot provide information about temporal trends.

A few questions were asked about the analyses for Indicator #17 (relative abundances, size distributions, and diversity of selected groundfish and trawl-vulnerable invertebrate species in Zone 3). It was explained that all the species were considered but only those that appeared to have some sort of trend were presented. Additionally, no additional lessons were learned from looking at abundance, so it was not presented.

Monitoring in the Gully MPA is very expensive, largely due to its offshore location and logistical challenges in getting to the site; therefore, the 2010 monitoring review (DFO 2010) mostly looked at opportunities available to leverage surveys that were already occurring. The difficulty is that the fish species that are of most interest occur on the canyon walls and floor, below depths of 400 m, where no existing survey can sample them. There are species that are small and resident in the area, but there is no method to effectively study them. It was suggested that a baited-camera survey could be considered to see if it could be used to monitor a replacement for Indicator #19 (relative abundances, size distributions, and diversity of selected trap-vulnerable species in Zones 1 & 2).

There was an increase in species codes from the RV survey over time. It was acknowledged that there have been changes in sorting/handling protocols and that there has been an increase in the number of species identified; however, currently, the identification of finfish species is pretty consistent. Overtime, there has been a gradual increase in the precision of identification of finfish caught in the RV surveys down to species level. There was less precision in the identification of the invertebrate bycatch.

Active acoustic monitoring was suggested as a method that could provide evidence for some of the energy inputs to the ecosystem hypothesized in the overview presentation. A discussion ensued regarding the benefits and challenges of using active acoustic monitoring in the Gully. The area is home to many species of cetaceans, and beaked whales are particularly sensitive to echo sounders. Additionally, there is Passive Acoustic Monitoring (PAM) being conducted in the Gully, so there would be timing considerations to ensure that the two types of monitoring do not interfere with one another. Changes to the frequency and duty cycle were suggested to reduce impacts on cetaceans, but it was pointed out that beaked whales have a large range of vocalizations, so there was some hesitancy to use active acoustic monitoring in beaked whale habitat for long periods of time without better understanding of the impacts.

DAY 2: TUESDAY, JANUARY 19TH

Rapporteurs: L. McConney, U. Goggin, and C. Schram

The Meeting Chair provided a summary of the previous day's presentations and discussion, which led to some additional discussion of the cetacean indicators. It was noted that in terms of the scale of change, the Gully is less variable than many other locations studied, which has implications on how the area is monitored. If the system is fairly stable, then the current method of collecting data and then analyzing large time intervals is sufficient. However, this can also result in vulnerability to sudden changes that would need to be detected as soon as possible.

It was noted that the reporting required for the Gully oceanographic indicators is different, and more qualitative, from the standard method used for Atlantic Zonal Monitoring Program (AZMP). AZMP does not have the resources to report on the Gully as a separate area on an annual basis, and the question was posed whether that should be a responsibility of the MPA Science group. Additionally, it was questioned if an annual report is necessary; perhaps a report every 3–5 years would be sufficient since there is no direct management of the oceanographic indicators, and there would not be a MPA management decision likely as a direct result of these indicators.

It was clarified that Indicator #25 (3-dimensional distribution and movements of water) was not being monitored, rather it was being used to characterize the ecosystem. This indicator would require more sampling and reporting than twice a year for monitoring purposes. It would require continuous monitoring and, therefore, a decision would be needed as to whether or not it would be worth the environmental impacts, cost, time, etc. While this indicator is difficult to measure and model on a fine time scale, it may be something that would be worth revisiting in the future in light of climate change. Indicator #25 might be worth dropping from the minimal suite of indicators because it is difficult to monitor regularly. Additional AZMP sampling could occur in July through leveraging of the summer RV survey.

While management responses in an MPA are not as quick and easy as changing a fishing quota, they do occur, and what is learned from monitoring the Gully MPA could benefit other MPAs. Additionally, DFO needs to be prepared to share with the public how MPAs are doing and how they are benefiting Canada.

There was discussion regarding doing additional coral surveys in Zone 1, or focusing efforts along the edge of Zone 2, where fishing occurs close to Zone 1. This would help to determine whether there are corals present that can be impacted by fishing gear.

The possible use of eDNA was identified as a potential technique to contribute to knowledge about the benthic indicators. It was noted that there was a large effort to barcode the mesopelagic fish in the Gully MPA but that has not been done for coral. DFO recently hired a geneticist, and this could potentially be one of the tasks for that person.

INDICATOR #8 (CETACEAN PRESENCE – ACOUSTIC MONITORING)

H. Moors-Murphy, J. Stanistreet, and C. Evers presented on cetacean monitoring in the Gully MPA. The objectives of this presentation were to provide an overview of results from 2012–2014 and more recent analyses (2015–2019). These are still preliminary results, and full analyses will be published in the primary literature.

The Gully is a whale hotspot, and baleen whales, beaked whales, sperm whales, and delphinids are all common in the Gully. Zone 1 of the Gully is critical habitat for Northern Bottlenose Whales (NBWs). The area is also important habitat for Blue Whales. NBWs have been sighted all along the Scotian Slope. Most sightings are concentrated in the deeper waters (400–1,500 m) of the Gully and surrounding canyons, although acoustic monitoring has revealed that the whales forage between these canyons as well (DFO 2020). Since the whales move around, there is need to focus on protection both inside and outside of the MPA. NBW in the Gully do both shallow and deep dives (often exceeding 1,000 m).

A passive acoustic monitoring (PAM) program was initiated since the last Gully monitoring review. The Maritimes Region PAM program aims to detect presence of cetacean calls. Recorders used record from 10 Hz–250 Hz, which covers the full frequency spectrum used by cetaceans. The recorders can be deployed down to 6,000 m. Some challenges with the program include data storage and accessibility, analysis protocols, and dedicating long-term analysts.

Baleen whales (Blue, Fin, Sei, and Humpback) were detected throughout the year in the Gully. As with other species groups, previous analysis has been published. Blue Whale calls peaked in summer and winter, Fin Whales in winter, Sei whales in summer, and Humpbacks in winter. Again, these results should be considered minimum estimates of species presence. Fin whales were generally the most commonly detected species.

It is important to note that not all call types were analyzed, and calls of some species (e.g., Minke) were detected but not yet analyzed. This analysis is a subset of the cetacean species known to inhabit the Gully. Future work should ensure consistency in both data collection and analysis. Data sets that can be used to distinguish calls are not presently available; however, there are groups working on this. There is a lot of variability in the call types. It was suggested that monitoring should continue for the long term, and support for analysis should be increased. Analysis should be expanded to cover more call types.

There is a possibility to look at the diurnal patterns of NBW and how the whales are using the Gully ecosystem over time. Currently, the data are used to determine only presence of species over time, not abundance. There is some work done to examine local densities of whales, but it is still too hard to connect acoustics with densities. It might be easier to do so for Sperm Whales, but calculating a number for beaked whales is unlikely any time soon. Determining the calling rates per species would take a lot more time and effort than it is to get the number of calls per site, and the abundance of a species would still not be known.

The present suite of detectors cannot really distinguish all of the call types because many are very similar. There is always need for some manual validation. The performance of automated detectors can be affected by background noises; for example, noise from a ship can interfere with the results. So, if background noise causes disruptions, it is important to be able to detect this interference. There is also the problem with too much noise associated with extra detectors and noise from the instruments. In the past, small instrumentation with low noise levels were used to monitor tagged fish, but there is a need to be careful of increasing the noise levels. Dalhousie University is currently working on North Atlantic Right Whale calls using Artificial Intelligence (AI), but this is not the answer for now as it still needs a lot of work to get it really reliable, even for Right Whales.

There is need for investment in data storage and archiving given the large amount of acoustic data that are collected every year.

A question was raised about the risk of building a pile of anchor weights (which are presently old train wheels) at the PAM site in the MPA, given that there is a new deployment every year. There is a 1 meter square area that is affected by each wheel, which is believed to be acceptable for now. In the long term, this may not be acceptable and new methods for anchoring equipment may be needed.

INDICATORS #9–12 (REPORTED CETACEAN INCIDENTS)

T. Wimmer presented on cetacean incidents in and around the Gully MPA. The information presented was likely an underrepresentation of actual incidents. Incident types include dead beached carcasses, dead floating carcasses, live stranded, and live free-swimming distressed animals. About 27 different species have been recorded by the Marine Animal Response Society (MARS). The availability of data and resources are the limiting factors to what can be done. A 20-year retrospective of incidents on the east coast of Canada is currently being compiled by MARS. A total of 4,900 records of cetacean incidents have been recorded over the past 20 years.

Several data considerations are necessary when analyzing cetacean incidents. These include the fact that the recorded locations are usually not where the incident occurred because the animals move. Species confirmation is also difficult and unreliable, particularly for floating dead animals. The cause of death/injury can also be very difficult to determine. For many incidents, cause cannot be detected externally.

From 1990–2019, there have been about 60 incidents around the Gully; 3 of them within the MPA. These are only the incidents that were reported to the organization and does not include data from fishery observers. Incidents in the MPA include a Humpback, a Bottlenose Whale, and a Sowerby's Beaked Whale. All three of these were entangled with fishing gear. The two incidents in the 40 km buffer involved a Humpback and a striped dolphin. The majority of incidents were in the 100 km buffer, and most do not report the cause(s) of death. A significant number were found beached on Sable Island. There were 16 different species identified in total. NBW incidents have occurred all around the region, including in areas well outside the expected range of NBW.

The limitations with these data include reporting, data-sharing, surveillance, funding/resources, and access to information and the animals (incident data collection). If a distressed or dead animal is sighted by a research vessel, then a number of factors may have to be considered to determine what can be done including safety, etc. Photos, samples (skin, swabs, fecal samples) etc., can be collected, and MARS is currently developing sampling protocols that would provide guidelines. In 2011, there was discussion about incorporating an offshore response protocol and response kits to Canadian Coast Guard vessels. These discussions were documented and can be shared with MARS.

It was suggested that indicators should be able to provide information on cetacean population health in general, not just mortalities or logged incidents. Monitoring for harm and harassment should be occurring, for the purposes of the MPA. This is also a requirement under the *Species at Risk Act* (SARA). It was also recommended that monitoring should include scar analysis and studies of body condition. Two data streams were recommended, one on mortality and

incidents, and the other on general health/body condition of live, free swimming animals to provide information for individuals as well as populations as a whole. Discussions have been occurring about using eDNA to monitor health of animals in the MPA. Research on the monitoring of stress hormones in animals could be used on whales once the method is further developed.

Ship strikes are difficult to pinpoint, and while it may be possible to deduce where an animal drifted from, it is very difficult to determine when exactly the animal died. Determining the specific vessel involved is very difficult. Although most strikes are likely from big ships, smaller ships can also cause damage. For necropsies, North Atlantic Right Whales (NARW) are the only species that will definitely get a necropsy. For other species, MARS can apply to a necropsy fund when an animal dies. Necropsies are one of the most fundamental things that needs to happen to obtain data and information on incidents. Out of the 4,900 incidents over the past 20 years, very few have had necropsies. An external fund for necropsies would be very beneficial.

In terms of surveillance flights, it would be beneficial to increase the number of flights and the design of recommended tracklines so that the flights would provide as complete coverage as possible. The National Aerial Surveillance Program (NASP) is just one surveillance program, but there are others. Those flights are not dedicated to the Gully; it just includes that coverage.

There was general discussion and differing views on what is required for cetacean monitoring and what is needed for monitoring the MPA. The state of the MPA may not be known by monitoring the general health of marine mammals because it is very hard (almost impossible) to directly link marine mammal incidents to the MPA. While monitoring health and harm to the whales is very important, the idea from the original indicators was that if there were marine mammal incidents occurring in the vicinity of the MPA, the MPA managers should know about it. Some participants were of the view that more monitoring of marine mammal health is necessary, but such monitoring should feed into MPA monitoring. In terms of the Gully MPA, it was felt by some that if the conservation objectives of the MPA involve monitoring the animals within the MPA, monitoring the health of the animals should be included, particularly for NBW. Without broader monitoring, however, it would not be known if the MPA is having any effect.

INDICATORS #1–7 (CETACEAN – SURVEYS, GENETICS AND CONTAMINANTS)

Rapporteurs: U. Goggin and C. Schram

L. Feyrer and H. Whitehead presented on research on the abundance of NBWs (Indicator #1) in the Gully MPA. The last assessment for the period 1988–2011 indicated the population of NBW was stable at approximately 146 individuals. Between 2004 and 2010, there was a change in trend as population decreased (−3.7 to −0.8) but from 2010 the population started increasing. This present update includes new data (1988–2019) and new modelling methods. Best supported models show a change in trend around 2010. Pre-MPA designation, the trend was decreasing, whereas post-MPA designation, it looks like the population is beginning to increase. Sighting rates and photo identifications both show increases. Post-MPA designation, the population is approaching approximately 200 individuals.

It is not certain whether the designation of the MPA precipitated the change in NBW population around that time. Other human activities could have impacted the stabilization of the population;

however, it would be interesting and meaningful to be able to pinpoint the MPA as a factor in the changing trend.

While the NBW population size is increasing, it is currently at a level of concern. There may be a carrying capacity for this area that is not known. Monitoring areas outside the Gully is also important to understand what is happening to the population as a whole. The Committee on the Status of Endangered Wildlife in Canada (COSEWIC) has considered the NBW population endangered for nearly 20 years. From a species at risk point of view, COSEWIC considers a threshold of 250 mature individuals to help assess if the species is endangered. Currently, there are about 200 individuals, of which two-thirds are mature. Rates of decline are also considered, so an increasing trend as observed here is very good news. It was suggested that maybe this indicator should be rephrased as “maintaining population size” rather than abundance.

L. Feyrer continued the presentation on the use of the Gully MPA by NBW (Indicator #2 – percentage of the population within the MPA). Visual effort, photo identification, and acoustic surveys have been used to assess use of the Gully. The best supported models show residency in the Gully more than in other surrounding canyons. Movement models suggest that there is more movement into the Gully from other canyons than the other way around. There is some small-scale movement out of the Gully. Satellite tags on animals in the Arctic recorded individuals making large-scale movements to areas off Newfoundland; however, it is not known how common it is for such migration to occur.

It is difficult to monitor temporal trends in use. It was suggested that this indicator could be reworded to look more at habitat connectivity. The indicator asks for a percentage of the population that lives within the Gully MPA. Part of the rationale for this was to make sure the signature species of the Gully is still using the Gully. It is believed that the proportion of animals using the Gully has likely stayed constant over time. Some individuals have been visually recorded many times in the Gully, with some recorded consistently over 30 years, while individuals were only seen once or twice. This calls for the need to think about the carrying capacity of the Gully.

J. Yeung presented on Indicator #3 (age-sex structure of NBW). The NBW can be age-sex classified by melon analysis, molecular sex by biopsy, and sightings information on group composition. Modelling trends show no significant differences in sex ratios between the canyons. The most significant trend observed was temporal, with more males present in late summer. An increase in mature males post-MPA may be reflective of an ageing population. Additional analysis is required to determine whether differences in sampling periods pre- and post-MPA designation may be influencing interpretation of sex ratios. Group composition from sightings indicates similar trends and provides information that calves are increasing, which indicates that the Gully may be a breeding area. As the age-structure of a population may reflect recovery trends, monitoring should continue. Body size has not been measured for 20 years, so this could be updated and potentially include body condition (this could inform a health/status indicator).

L. Feyrer presented on Indicator #4 (scarring in NBW, proportion of fresh scars). Notches, back indents, patches, fin scars, and entanglement scars were all studied over the period 1988–2019 using photo-identification. Only notches and back indents were stable over this time scale and can be used for identification. About 48% of the population have these markings. Males have a greater percentage of most scar types. The percentage of most mark types is increasing, which could be due to individuals accumulating scars and marks as they age, or as a result of factors

occurring outside the MPA. Anthropogenic markings can come from fisheries or vessels (propeller scars). Between 1988–2019, 15 NBW and 26 Sowerby's whales have been documented in published literature as entangled or caught. In the photo-identification analysis, anthropogenic marks were consistently observed throughout the period. The estimate of anthropogenic injuries is concerning, as it is greater than Potential Biological Removals (PBRs) (see Feyrer et al. 2021). It was suggested that "fresh" scars be removed from the wording in the indicator; leaving it as just "scarring and markings" in general. Trends over time were evaluated by looking at the proportion of marked versus unmarked individuals in the population each year, and then using General Linear Models (GLMs).

The term "fresh scars" came from what was thought to be observable at the time this indicator was proposed, and determining whether a marking was anthropogenic or was not thought to be possible at that time. Over time, knowledge and capabilities have evolved, so now it may make more sense to focus on anthropogenic scars as opposed to "new" or "fresh" scars. There are now different categories of scars, and there is some certainty that some scars are anthropogenic; there are some markings that cannot be attributed to any one cause.

Photos of scars came from individuals in the Gully, Shortland, and Haldimand canyons. It is not known where the scars are coming from, or whether the interactions with fisheries are occurring within the Gully, the other canyons, or elsewhere. Longline fisheries occur in parts of the Gully, and there is ghost gear that could be impacting the whales as well. This provides evidence that areas outside the MPA have to be considered in order to protect these species. Another ongoing theme is that what we want to monitor and protect often goes on outside of the MPA boundaries. It may be possible to look at distribution models for NBW and overlap them with fisheries data layers to help determine areas where the risk of these interactions is higher.

Indicator #5 (genetic diversity of NBW) was presented by L. Feyrer. The low genetic diversity of NBW could be a concern for rebuilding populations. The population of NBW on the Scotian Shelf is genetically distinct. The Scotian Shelf population has had a dip in genetic diversity over the past 200–300 years (a historic genetic bottleneck). Genetic diversity is important, but there is no expectation of temporal trends. Changes in population structure may be a more appropriate indicator than genetic diversity.

There is value in repeated measurements, but given the sample size of NBW and changing metrics, diversity may not be the best metric for measuring change. Using genomic methods and being more specific about population mixing might give a better idea of connectivity. Some of these indicators are very method-specific because they have to be achievable, but methods change over time and that should be taken into consideration. For this indicator, both genetic diversity and changes in population structure should be monitored. If diversity declines over time, it suggests more and more inbreeding and little gene flow. If diversity increases over time, this can lead to increased resilience to stressors. Using genomic data instead of microsatellites could refine our understanding of population structure and lead to diagnostic markers that could be used to rapidly identify changes in structure over time.

Indicator #6 (levels of contaminants in NBW), presented by L. Feyrer, aims to monitor Persistent Organic Pollutants (POPs), heavy metals, and micro-plastics that can be potential contaminants for NBW. Two studies have been done on POPs and NBW. Trace elements have been found in NBW, but the data have not been analyzed. Contaminant concentrations can vary greatly across sex/age, species, migratory behaviour, and foraging depth. The levels of most POPs were higher in Scotian Shelf NBW than Arctic NBW. Overall levels of Dichloro-Diphenyl-

Trichloroethane (DDT) were higher than Polychlorinated Biphenyls (PCBs), suggesting there may be a local environmental source. Temporal trends suggest POPs have increased since 1997. Other contaminants may be a concern and should be monitored. Overall, ongoing monitoring of contaminants is very important. The reference to blubber in the wording of the indicator could be removed, as contaminants can be measured in other parts of the body as well.

If there is one particular contaminant or group that is most relevant to monitor, it would be POPs since they have been monitored over the long term and should continue to be monitored. Considering this population's health and vulnerability, the presence of contaminants is a concern. Micro-plastics can only be measured in dead animals, so we can only measure them opportunistically. If there are known sources in the ocean, it would be easier to relate levels to sources; however, given that the analyses are for 30+ chemicals, determining the source would be very difficult.

There was a Science Advisory Report (SAR) in 2009 on contaminants in the Gully.

H. Whitehead next presented on Indicator #7 (the relative abundance of other cetaceans in the Gully MPA). There are frequent sightings of NBW, Sowerby's Beaked Whales, Long-finned Pilot Whales, Short-beaked Common Dolphins, and Atlantic White-Sided Dolphins, Blue Whales, Fin Whales, Humpback Whales, and Striped Dolphins. Occasional sightings include Minke Whales, Sei Whales, Risso's Dolphins, and Bottlenose Dolphins. Rare sightings include Cuvier's Beaked Whales, White-beaked Dolphins, Fraser's Dolphins, and Harbour Porpoises. Sperm Whales were not monitored here because of survey effort bias. There has been a decrease in sightings over time for Humpback Whales, White-Sided Dolphins, Striped Dolphins, and Fin Whales; while increasing sightings were recorded for Sowerby's Beaked and Pilot whales. Blue Whale abundance peaked in about 2005, and NBW decline reversed around 2010. For other species with much wider ranges these changes cannot be firmly related to population and is much more likely due to changes in habitat use. Overall, these trends are informative over longer timescales and provide information on habitat use within the Gully MPA. There is not enough data across the region to make conclusions about the reasons for decreases in some of these species on a similar timescale.

There are issues with both sightings and acoustic detections; for example, Humpback Whales can be difficult to identify acoustically, whereas they are quite identifiable visually. In the case of other species, it is the opposite. Sightings can really only happen for about 3 months of the summer when the weather is nice in the day, whereas acoustic recorders can work year-round. Integrating information from both sightings and acoustics will give a more complete picture, although it is not easy to do. Towing hydrophones behind a visual survey vessel is an option that has been tried, but, for the most part, the two streams have been analyzed separately.

Based on acoustic detections, more Cuvier's Beaked Whales should be sighted; however, they make long and deep dives and do not spend much time at the surface. It may be possible to aggregate some of these datasets and different species with similar trends could be aggregated. Both Finback and Humpback whales have similar visual abundances that can be related to the presence of small pelagic fish species. Three of the dolphins species also have similar trends, and these trends and connections need to be looked at over time.

The presentations for the day were followed by some general comments on indicators. The more generic the indicators, the better they can be adapted over time. While generic indicators

is a good idea, if consistent methods are used, it would be easier to compare and track them over time. As long as methods are comparable, trends over time can still be deduced. Making the indicators more goal-focused and less method-based could help. If the indicators are focused on goals or targets, specific methodologies would not be as important. Samples are presently being preserved as best as possible for possible future changes in methodology.

DAY 3: WEDNESDAY, JANUARY 20TH

Rapporteurs: U. Goggin and R. Singh

Day 3 started with Chair providing a summary of the previous day's presentations and discussions.

INDICATORS #21–23, 26–27 (OCEANOGRAPHY)

L. Beazley and E. Head presented on certain aspects of oceanographic indicators 21, 22, 23, 26, and 27. Indicators 24 (weather conditions), 25 (3-D movement of water masses), and 28 (acoustic scattering data) were not evaluated. The AZMP conducts biannual surveys (spring and fall) across the Scotian Shelf, and aim to sample 4 monitoring stations in the Gully. However, it is often not possible to occupy these stations, as they are not considered part of the program's core monitoring. Nonetheless, despite the limited, seasonally-defined time series, the results presented showed statistically significant, increasing trends in mid-depth temperatures at all stations in the Gully, and also highlighted several redundancies in the AZMP's existing sampling scheme of the MPA. Monitoring should continue at station GULD_03 located near the Gully head, and GULD_04 located at the Gully mouth. However, continued monitoring of eastern and western Gully mouth stations SG_23 and SG_28 provides little additional value given their redundancy to station GULD_04. The presenters discussed whether there was value in adding a monitoring station in Gully Zone 3, which at present is not monitored. The consensus was that oceanographic monitoring of Zone 3 would likely add little value to the AZMP's existing sampling scheme, as the southwestward current that flows over the Gully suggests that the conditions in Zone 3 would likely be similar to those observed at station GULD_03. It was suggested that it would be possible to occupy at least some of these stations during the summer ecosystem research trawl survey (July–Aug) of the Scotian Shelf, of which the AZMP participates to collect hydrographic and biological data.

The collection of acoustic scattering data in the water column of the MPA (Indicator 28, not assessed during the meeting) was discussed. Acoustic data were collected during previous AZMP missions but has long been discontinued. While there are limitations related to the frequency of data collection and the lack of required expertise to analyze the collected data, better estimates of certain zooplankton species could be obtained using acoustic measurements collected from towed or moored devices. The group suggested that the new offshore fishing vessels (e.g., *CCGS Jacques Cartier*) have the required sounders onboard and could represent a means to collect acoustic scattering data in the Gully in the future. Considerations would have to be made in relation to the analysis of these data and how they may be incorporated into regular monitoring of the zooplankton communities of the MPA.

Indicator #25 (three-dimensional distribution and movements of water) was not directly assessed during the meeting and was not considered feasible to monitor on a regular basis due to the costs of deploying year-round moored devices. Nonetheless, sampling twice a year does

not provide the temporal coverage required to track changes in water masses, the drift and flow of which may change within 2–3 hours. Year-round data would be required in order to evaluate Indicator #25. This would greatly enhance the AZMP's ability to evaluate temporal changes in other oceanographic parameters within the MPA. However, there is not enough staff to process the data, and there is need for capital resources if a permanent mooring was to be contemplated. Presently, the cost to do this is prohibitive.

On Indicator #27 (zooplankton) - while it is known that some copepods (e.g., *Oithona* spp.) have been shown to be sensitive to ocean acidification in the Arctic, the present data indicates that there has been no significant changes in pH in the Gully. Zooplankton abundance and composition appeared to be associated with the presence of different water masses within the Gully MPA. However, these trends were confounded by differences in the timing of AZMP sampling and biological events, such as the timing of the spring bloom. It would be helpful to highlight the taxa that could be considered indicators of changing hydrographic conditions. This would result in more targeted indicators for the "selected species" in this next round of monitoring. Perhaps also some species that are key to food web dynamics could be justified at the same time. Looking at species groups may provide a multidimensional view.

Modeling work is valuable for interpreting processes in the Gully, and ocean models have improved significantly over the last 10 years. Such improvements may result in even more insights. There has been a lot of modelling work done at Dalhousie University. The modeling done so far was strictly physical, so the next step might be to look at biogeochemical (BGC) modeling to understand the coupling of physics, chemistry and lower trophic level biology. Modelling is also being done to project what will happen to some key coral taxa (e.g., *Paragorgia*), and they are all predicted to disappear from the Gully and Scotian Slope with climate change. This type of research will provide information that can be used to anticipate how key ecological functions (i.e., recruitment) may change under climate change and, thus, may be used to structure future monitoring.

While the AZMP data collected in the Gully are post-processed and archived by BIO Data Services, they are not analyzed as part of the program's annual reporting. The AZMP reports on the Scotian Shelf on a larger scale, and it is possible to see annual trends that may be applicable to those occurring in the Gully. The analyses presented at the meeting showed that, while AZMP core station LL_07 would act as a proxy for the conditions occurring at the Gully head (GULD_03), stations downstream of the Gully (HL_06) are quite dissimilar to those in the canyon. While there are some considerations related to DFO's existing data archival and accessibility processes, and which group will be responsible for conducting annual reporting of the Gully and other MPAs in the future, the technical report produced for the meeting represents the first attempt at automation of analyses that would evaluate temporal changes in the oceanographic conditions of the MPA, which could serve as a template for future reports. Nonetheless, human resources would still be required to generate a summary each year or every 3–5 yrs. There is a need to put more thought into data reporting and sharing.

INDICATORS #13–16 (CORALS AND BENTHOS)

The next presentation was by E. Kenchington on the benthic indicator monitoring within the Gully MPA. Prior to establishment of the MPA, there were 90 in situ photo transects conducted. Following the establishment of the MPA, there have been 57 in situ photo transects, the most recent being conducted in 2019. These total 105 hours of video and 3,949 photos. Some of

these locations were randomly selected, while others targeted specific features of the Gully, making it difficult to use all of the data to infer population characteristics. Further, none of the transects repeat sampled a previously sampled transect, so cannot be used for trends monitoring; however, they provide baseline data on both coral diversity, density, and size structure (Indicators 13 and 14) for future repeat sampling efforts. Over the past decades, the primary objective of these activities was to characterize the benthic species, including corals, in the MPA. Many transects were obtained opportunistically and were not planned as monitoring activities. Sponges remain important sensitive benthic species that have not yet been adequately documented in the MPA. A possible new genus (that needs specimen collection) was documented by the Okeanos mission in 2019. It was stressed that a data repository is needed to archive these and other data from the Gully. Data rescue of the photo and video data has been undertaken by the research team but is not complete. Having such data in one location would facilitate future monitoring efforts. Combining data from various ecosystem components in one repository would also facilitate future ecosystem research.

With respect to Indicator 15, which was to measure the proportion of live:dead coral, the temporal window that this indicator can report on was discussed. The large bubblegum coral, *Paragorgia* spp., and some other corals do not last long (< 1 year) after death, while species such as stony corals and the common bamboo coral, *Keratoisis* spp. persist much longer (> 1,000 years). The short-term disintegration of some corals would indicate more recent impacts, while bamboo corals could be good indicators of cumulative impacts over the long term. If there are concerns about fishing activity, then monitoring for effects on coral around the suspected areas could be undertaken within a planning window of one year or less. Since there is fishing along the edges of Zones 2 and 3, it would be good to look at the possible overlap between fishing and potential impacts on corals to prioritize those areas for future in situ transects. Since corals do not move, it may be possible to connect observed damage to the fishing activity by repeating transects when there is an event that might have posed a problem.

It was proposed that the data from the surveys be expanded to include indicators for sponges and xenophyophores, both of which have important ecosystem functions. For Indicator 16, it was agreed that zooanthids may provide a good indicator of coral health.

Comparative analysis has been done to show benthic areas that are highly diverse. If there is a change, the cause has to be understood and then action taken. Currently, the transects are used to describe the canyon rather than determining threats. In terms of a monitoring strategy for corals, there are many different habitats and combinations of depth, slope, sediment types, etc., that influence fauna. While monitoring is desired, it is perhaps best if it is more extensive and not just intensely focused on the location of the existing transects. Focusing on shallower drift transects would require a different approach (stratified random), and this would mean specific areas cannot be targeted.

INDICATOR #29 (SEABIRDS)

K. Allard next presented on the seabird indicator. In terms of connectivity, it is known that terrestrial areas are connected to offshore areas, and measuring this connectivity could be useful. Fortunately, there is access to broader knowledge about the surrounding ecosystems. Now that Country Island (Nova Scotia) will be a National Wildlife Area, more monitoring will be happening there. There is potential for a long-term study into how the conservation area is being used, which can continue to be developed into the future.

Improved monitoring of birds is required to gather more information about population numbers, their feeding and breeding grounds, and areas of connectivity throughout the year. For example, storm petrel numbers are going down. There is a connection between Country Island and the Gully. Seabirds are travelling thousands of kilometers between the two areas. The longer-term interest is to explore seasonal variations in the Gully area.

Data on seabirds is gathered using at-sea observers. The AZMP has an at-sea seabird observer. Harmonizing monitoring efforts through AZMP and other programs would be very valuable. Efforts are being made between DFO and ECCC, along with others, to develop repositories of information. This will help to provide opportunities to explore the data in greater detail.

Tagging birds can demonstrate the connectivity between Country Island and other conservation areas. If birds move away, this could be indicative of change. Telemetry devices are also getting smaller and cheaper, so more use can be made of them. Right now, there is not adequate temporal coverage for birds in the winter months in the Gully. Telemetry may be able to help fill that gap. It may also provide information on species coming from the Artic to overwinter in the Gully area. It may also be worth exploring ships of opportunity and using cameras on these ships for some basic monitoring work. Drones and aircraft could also be used, if the need was warranted.

INDICATOR #47 (ANTHROPONIC NOISE)

J. Xu presented on the ambient noise recorded in the Gully MPA by acoustic listening devices. Most of the ambient noise were associated with meteorology and shipping. There may be future improvements in the ability to analyze these ambient noises. The indicators used should promote constancy of data collection, while data presentation is largely left to analysts. These analyses can evolve over time, as questions change and understanding increases; however, the archived data can be revisited as new metrics are developed.

The purpose of a noise indicator is to monitor anthropogenic noise that may have impacts on conservation priorities. This can be done by looking at this indicator in two ways:

- Look at noise trends over the long term gathered from monthly annual noise levels to detect if usual noise levels are exceeded.
- Investigate the sources, that is, if they are natural or anthropogenic. Then calculate the number of days per year that there are problems.

Noise levels could point to a particular point in time when there could potentially be effects on cetaceans. This could then signal a need for more investigation into impacts on cetaceans. Careful interpretation is needed because cetaceans may be very stressed by the noise but not moving away from it. If noise from ships is impacting conservation measures, it could lead to adaptive management, but this would not happen without monitoring. There is need for another meeting to discuss noise and consider its effects on different species.

DAY 4: THURSDAY, JANUARY 21ST

Rapporteurs: U. Goggin and R. Singh

The day started with a review of the previous day's presentations and discussions by the Chair, T. Worcester. This was followed by the presentations on human stressors (vessel presence and speed, fishing pressures, corals removed or discarded, seabed swept, oil and gas, and large floating debris and invasive species) by L. McConney, G. Pardy, K. Rozalska, C. Schram, E. Will, and J. Wingfield.

INDICATORS #30–31 (VESSEL PRESENCE AND SPEED)

The results of the AIS data analyses showed that commercial vessels often transited through the Gully at speeds greater than 10 knots, which suggests that the voluntary speed restriction of 10 knots within the Gully MPA has not served as an effective measure for reducing vessel speed. DFO should work with Transport Canada to explore additional options for reducing commercial vessel speed within the MPA.

Concerns were raised about using broadcast/reported speed over ground values instead of calculated speed values for non-fishing vessels. To stay consistent with the most common approach in the published literature, calculated vessel speed will be used for all subsequent analyses. This includes the results presented in the Science Advisory Report.

It was suggested that commercial and fishing vessel activity be analyzed using the same methods. Due to the differences in speed and behaviour of commercial and fishing vessels, the authors will continue analyzing these vessels separately. In addition, AIS data availability (used for commercial vessel analyses) was reduced by downloading and decoding requirements and had more errors compared with VMS data (used for analyzing fishing vessels). It was suggested that the fishing data from VMS be broken down by gear type and year. Although not required to address the indicators, the authors had investigated this additional type of analysis and will provide an example and discuss the possibility of using it in future reports.

INDICATORS #32–34, 36-37 (FISHERIES PRESSURES)

Information on fisheries pressures came largely from the Maritimes Region Fisheries Information System (MARFIS) and At-Sea Observer Records. Several issues with these data sources were noted, including the uncertainty over what proportion of catch from pelagic longlines came from the MPA, as sets often extend from within and outside the MPA given their length and drift. The proportion of fish relative to the proportion of sets inside the MPA is not reported in landings records. Therefore, the numbers of pelagic fish reported for the MPA were likely an overestimate. With respect to bycatch, the kept weight and the discard weight are recorded (estimated) in the at-sea observer database. Landed species are recorded in the MARFIS database and given a more accurate weight. It was noted that, if possible, noting the condition of discards would add to the understanding of fisheries impacts in the MPA.

Evaluating biomass removals of landings and bycatch using records from commercial fisheries logbook data appears unreliable. Recorded fields such as location, gear length, and number of hooks may not always be accurate. An effort to validate some of these fields could help to improve these analyses. It was noted that due to fluctuating levels of At-Sea Observer coverage, an estimate of bycatch per unit of effort would be useful. Low observer coverage adds to uncertainty over the accuracy of bycatch data, particularly for pelagic longline which had

few observed trips. It was noted that using VMS records could add an additional measure of effort that could be compared to landings and bycatch levels in the MPA.

Discussion on observer training and data collection followed. and there is concern that there is underreporting of bird bycatch, often related to level of observer training as well as low observer effort. There has not been any recent observer training, but there is need to consider training for new observers and giving experienced observers a refresher course. With only 5% observer effort, any true variation will be difficult to detect. Rather than using observer records, a suggestion was made to look at analyzing bycatch per unit of halibut landed. This could also be done using pelagic species. There is need for strategies to increase observer effort, training, and public access to information relating to fishing activities within protected areas.

MARS has also done training with fisheries observers (as well as fisheries officers) on the identification of live and dead cetaceans (as well as sharks and sea turtles). They have also developed materials to support this kind of training. It also includes information on reporting and what kind of information to collect and document. MARS may be willing discuss how to expand these efforts.

It was suggested that, in the future, more information on fishing effort should be collected for the pelagic fisheries (e.g., length of lines, number of hooks, etc.). This will provide information on entanglement risk, and could help to enable more catch-per-unit-effort analysis for both landings and bycatch. Using the number of hooks as a measure of effort was unreliable because of uncertainties in the commercial logbook records. Therefore, the presented catch weights were not effort corrected. It would also be helpful to know if the amounts being removed is because there is more effort. This indicator (#36) is for amount of biomass removed, not catch rates, indicating relative abundance of fish removed from the MPA. However, an effort corrected analysis would indicate whether amounts being removed are correlated to levels of effort, which would likely be a more informative indicator than simply calculating overall weight of biomass removed from the MPA. Additionally, a suggestion was made to potentially expand the buffer zone depending on the species being looked at, for example using a larger buffer for wide-ranging pelagic species.

A national study is underway using data from Vessel Monitoring System (VMS) or Automatic Identification System (AIS). The data are characterized into presumptive activity and the technology can be used to visualize, track, and share information about global fishing activity. VMS data is generally reported every hour. The VMS hardware standard is being updated so that positional reports can be provided every 5 minutes (Developing a new Vessel Monitoring System standard). Such resolution will enable study of potential interactions involving vessels and Leach's Storm Petrels from large Nova Scotian colonies, including Country Island. Work is underway to analyze the 2012–2019 AIS data for MPAs nationally, using algorithms to calculate fishing effort.

INDICATOR #35 (CORALS REMOVED OR DISCARDED)

There were sporadic records of corals collected by observers. It was suggested that a slight modification be made to show the overlap between fishing activity and presumptive distribution of coral habitat to provide some spatial context for the fishing effort. With higher resolution versions of the fishing-effort maps, effort around the heads of feeder canyons can be examined in greater detail.

INDICATORS #38–42 (SEABED SWEPT, OIL AND GAS)

The human pressures report states that the Deep Panuke project was been decommissioned in 2020 (same as the Sable Offshore Energy Project [SOEP]). Data from offshore-petroleum activity are readily obtained from the Canada-Nova Scotia Offshore Petroleum Board (CNSOPB), so it is possible to summarize this for the use in the MPA management. The drop in the number of oil and gas spill/discharge is due to reduced oil and gas activities, not because of the creation of the MPA, although the timing may appear to be co-incident.

INDICATORS #44–46 (LARGE FLOATING DEBRIS AND INVASIVE SPECIES)

It was suggested that when requests are made for activity within the MPA, applicants should be asked to report more information on debris. This information is currently requested from whale and turtle researchers.

The data from the RV survey indicates that some species, such as Blackbelly Rosefish and John Dory, are moving north. They are reproducing in the Fundian Channel and along the Scotian Shelf edge. The RV survey is very important for collecting information on invasive species.

It is hard to apply adaptive management if there are no thresholds for what is considered a significant pressure change in the data for indicators. With the current indicators, there are no triggers for management actions. The benthic indicators can be used for management closures when there is clear evidence. There are no established targets for many indicators including NBW, there are only thresholds. There is no indicator management framework for the MPA. A first step is to overlay spatial information on priority species/habitats with the human pressures that impact them. This will inform any potential new zoning, or at least areas of high (and potentially damaging) interactions.

In the Pacific Region, work is being done to determine thresholds by performing an ecological risk assessment to get to the specifics and their impacts. This will guide the identification of regulation when needed. The Pacific MPA also have electronic monitoring. The cost associated with such monitoring is currently too high for Atlantic MPAs, but such data would enhance fisheries reporting. Industry has been resistant to video monitoring on the east coast for various reasons. A more comprehensive understanding and documentation of the gear types and fishing lines surrounding the Gully MPA would be useful.

Day 4 continued with participants reviewing the draft Science Advisory Report (SAR) posted on the Google shared drive. Participants were encouraged to make suggestions and edits to the document.

DAY 5: FRIDAY, JANUARY 22ND

Rapporteur: R. Singh

Day 5 started with a quick review of the status of the SAR by the Chair. This was followed by continued discussion on ways to improve the document and the advice. At the end of the session, participants were encouraged to continue to provide suggestions and edits to draft document. It was agreed that the assessment team will provide summaries to be included in the SAR, and the document would then be circulated to all participants for feedback before being finalized.

FINAL REVIEW OF SAR: THURSDAY, OCTOBER 14th

The meeting was re-convened on October 14, 2021, to review a revised Science Advisory Report based on the discussion from the previous meeting and further input from meeting participants. This meeting was chaired by T. Worcester, who thanked N. Jeffery for assembling participant comments and feedback into the current draft for review. The focus of the discussion was on finalization, through consensus, of the summary bullets, and whether these adequately captured a summary of key conclusions from the meeting. The final bullets that were agreed to can be found in the published SAR.

In general, participants appreciated the more consistent approach to the organization and reporting on the indicators, with further suggestions on where to place things such as the sources of uncertainty (i.e., debating whether to include within individual sections or as a summary at the end of the report. There was agreement that only key conclusions or results (e.g., notable trends) would be included in the summary bullets, to reduce its overall length.

It was agreed that the final table of recommendations would be included within this proceedings document, rather than within the SAR. See Appendix D.

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APPENDIX A: TERMS OF REFERENCE

Gully Marine Protected Area Monitoring: Review of Research Activities, Indicators, and Guidance on Next Steps

Regional Advisory Meeting – Maritimes Region

January 18-22, 2020
Virtual Meeting

Chairperson: Tana Worcester

Context

The Gully is the largest submarine canyon off eastern North America, supporting a rich diversity of habitats and species, including cold-water corals and deep-diving toothed whales. The area is acknowledged, nationally and globally, as a unique and important focus for conservation. Available scientific knowledge of the area was first drawn together by Harrison and Fenton (1998) and later updated by Gordon and Fenton (2002), following additional targeted research. In 2004, the Gully became Canada's first *Oceans Act* Marine Protected Area (MPA) to be designated in the Atlantic Ocean.

In 2008, a Management Plan was completed, providing support for the MPA regulations and guidance to Fisheries and Oceans Canada (DFO), other regulators and users on the protection and management of the MPA. Conservation objectives and sub-objectives specified in 2008 were maintained and recast as conservation goals for the second edition Management Plan (DFO 2017). The overarching goal for the Gully MPA is to protect the health and integrity of the Gully ecosystem. Sub-goals for the MPA are to:

- 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.

A framework for monitoring the MPA, including 47 proposed indicators, was prepared in 2010 to support the conservation goals and objectives (DFO 2010, Kenchington 2010). Available data, sampling protocols and monitoring programs supporting these indicators were later reviewed in 2012 (Allard et al. 2015). Monitoring and research has since continued in the MPA, helping to expand our understanding of the ecosystems, while also establishing baselines for future work and supporting improvements to the efficiency and efficacy of future monitoring.

A decade after the initial proposal of indicators, there is an opportunity and need to revisit the Gully monitoring program, to examine the utility of the data being gathered, identify gaps in coverage, incorporate new knowledge, document progress towards baselines from which change can be assessed, and interpret any observed trends. Centrally, this review seeks to evaluate whether the MPA is meeting its conservation objectives and to determine whether the current monitoring activities are suitable for this evaluation. The review will be instrumental to the formalization of a feasible monitoring program and practical implementation strategies for the Gully MPA.

As Atlantic Canada's first *Oceans Act* MPA, a peer review of the monitoring and assessment of the Gully is expected to provide important lessons and perspectives for the development of

long-term monitoring programs at other offshore MPAs and ultimately for Canada's bioregional MPA networks.

Objectives

The objectives of this meeting are to review the performance of the Gully MPA in meeting its conservation objectives and to provide advice on how to move forward efficiently with monitoring. These objectives will be accomplished through:

- scientific peer review of available data (and baselines where they have been developed) for each indicator listed in the Gully Monitoring Framework (Kenchington 2010) or for alternative indicators developed subsequently;
- the evaluation and interpretation of any trends from those indicators with reference to the MPA's conservation objectives;
- consideration of advances in understanding of the ecosystems in The Gully, including a conceptual model of those ecosystems, to provide a foundation for development of more efficient indicators and improved understanding of how the indicators reflect ecosystem function within the MPA;
- determination of which indicators are useful in the evaluation of MPA performance, leading to recommendations for improvements to the existing suite of indicators, including the addition or removal of indicators, as well as improvements or additions to monitoring protocols/strategies;
- the development of a minimal suite of indicators suitable for MPA performance evaluation and the identification of any gaps in the current monitoring program that should be prioritized for increased scientific effort;
- examination of linkages between ecological processes in the Gully and those of the broader Scotian Shelf MPA network planning region (e.g., through connectivity, gene flow, source-sink dynamics).

Expected Publications

- Proceedings
- Research Document(s)
- Science Advisory Report

Participation

- DFO Science
- DFO Ecosystem Management
- Environment and Climate Change Canada
- Natural Resources Canada
- CNSOPB
- Nova Scotia Provincial Representatives
- Aboriginal communities / organizations

- Offshore Oil & Gas Industry
- Non-Government Organizations
- Fishing Industry
- Academics

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APPENDIX B: LIST OF PARTICIPANTS

Participants at the Gully Monitoring Review Meeting, January 18-22, 2021. Y = present, a dash (-) indicates absence.

Name	Affiliation	Day 1	Day 2	Day 3	Day 4	Day 5
Allard, Karel	Environment Canada, Canadian Wildlife Service	Y	Y	Y	Y	Y
Beazley, Lindsay	DFO Maritimes / Science	Y	Y	Y	Y	Y
Bone, Bryden	DFO Maritimes / MPC	–	–	Y	–	–
Brewster, Deanna	Department of National Defence/Defence Construction Canada	Y	Y	Y	Y	Y
Brilliant, Sean	Canadian Wildlife Federation (CWF)	Y	Y	Y	Y	Y
Couture, John	Unama'ki Institute of Natural Resources (UINR)	–	Y	–	–	–
Campbell, Calvin	NRCan	Y	Y	Y	Y	Y
Chaves, Lais	Council of Haida Nation / Pacific	Y	Y	Y	–	–
Clark, Don	DFO Maritimes / PED	Y	Y	Y	Y	Y
Coffen-Smout, Scott	DFO Maritimes / MPC	Y	–	–	–	Y
Cooper, Andrew	DFO Maritimes / CESD	Y	Y	Y	Y	Y
Couture, John	Unama'ki Institute of Natural Resources (UINR)	Y	Y	–	–	–
Creamer, Amber	NS Fisheries and Aquaculture	Y		Y	Y	Y
Doniol-Valcroze, Thomas	DFO Pacific Science	–	Y	–	–	–
Du Preez, Cherisse	DFO Pacific / ESD	Y	Y	Y	–	–
Dudas, Sarah	DFO Pacific / ESD	Y		Y	Y	Y
Edmondson, Elizabeth	DFO HQ / MPC	Y	Y	–	Y	–
Eguiguren, Ana	Dalhousie University / Biology		Y	–	–	–
Evers, Clair	DFO Maritimes / PED	Y	Y	Y	–	Y
Falille, Genevieve	DFO Quebec Science	Y	Y	Y	Y	Y
Fenton, Derek	DFO Maritimes / MPC	Y	Y	Y	Y	
Feyrer, Laura	DFO Maritimes Science	Y	Y	–	Y	Y
Gjerdrum, Carina	Environment Canada, Canadian Wildlife Service	–	Y	Y	Y	–
Goggin, Una	DFO Maritimes / CSA Office	Y	Y	Y	Y	
Gomez, Catalina	DFO Maritimes / CESD	Y	Y	Y	Y	Y
Greenan, Blair	DFO Maritimes / OESD	–	–	Y	Y	–
Harvey, Reanne	Canadian Parks and Wilderness Society	Y	Y	Y	Y	Y
Hastings, Katherine	DFO Maritimes /SARA	Y	Y	Y	Y	–
Head, Erica	Retired DFO	Y	Y	Y	Y	Y
Heaslip, Susan	DFO Maritimes / CESD	Y	Y	Y	Y	Y
Hebert, Dave	DFO Maritimes / OESD	Y	Y	Y	Y	Y
Hiltz, Jesse	NS Intergovernmental Affairs	Y	Y	Y	Y	Y
Iacarella, Josephine	DFO Pacific / ESD	Y	Y	Y	Y	Y
Jacobs, Kevin	DFO Maritimes / OESD	Y	–	Y	Y	–
Jeffery, Nick	DFO / CESD	Y	Y	Y	Y	Y
Kenchington, Ellen	DFO Maritimes / OESD	Y	Y	Y	Y	Y
Kenchington, Trevor	DFO Maritimes / OESD	Y	Y	Y	Y	Y
MacIntosh, Jessica	NRCan	–	Y	Y	–	Y
Macnab, Paul	DFO Maritimes / MPC	Y	Y	Y	Y	Y
Marotte, Emma	DFO Maritimes / MPC	–	–	Y	Y	–

Name	Affiliation	Day 1	Day 2	Day 3	Day 4	Day 5
Mataxas, Anna	Dalhousie University / Biology	Y	–	Y	Y	–
McConney, Leah	DFO Maritimes / MPC	Y	Y	Y	Y	Y
Moors-Murphy, Hilary	DFO Maritimes / OESD	Y	Y	Y	Y	Y
Mugridge, Adam	NS Fisheries and Aquaculture	Y	Y	–	–	–
Murillo-Perez, Javier	DFO Maritimes / OESD	Y	–	Y	Y	Y
Neves, Barbara	DFO NL	Y	Y	Y	Y	Y
Norgard, Tammy	DFO Pacific / ESD	Y	–	Y	Y	Y
Rozalska, Kasia	DFO Maritimes / MPC	–	–	–	Y	–
Rubidge, Emily	DFO Pacific / ESD	Y	–	Y	Y	Y
Saunders, Sarah	WWF-Canada, Atlantic Region	Y	Y	Y	Y	–
Schram, Catherine	DFO Maritimes / MPC	Y	Y	Y	Y	–
Shackell, Nancy	DFO Maritimes / OESD	Y	Y	Y	–	–
Singh, Rabindra	DFO Maritimes / CSA	Y	Y	Y	Y	Y
Stainstreet, Joy	DFO Maritimes / OESD	Y	Y	Y	Y	Y
Stanley, Ryan	DFO Maritimes / CESD	Y	Y	Y	Y	Y
Tekamp, Mark	NS Energy and Mines	Y	Y	Y	Y	–
Thillet, Marielle	Canadian Association of Petroleum Producers	Y	Y	Y	Y	Y
Vanderlaan, Angelia	DFO Maritimes / OESD	Y	Y	Y	Y	Y
Vascatto, Kris	Groundfish Enterprise Allocation Council	Y	Y	Y	Y	Y
Whitehead, Hal	Dalhousie University / Biology	Y	Y	Y	–	–
Will, Elise	DFO Maritimes / MPC	–	–	–	Y	–
Wimmer, Tonya	Marine Animal Response Society	Y	Y	–	Y	Y
Wingfield, Jessica	DFO Maritimes / MPC	–	–	Y	–	–
Worcester, Tana	DFO Maritimes / CSA - Chair	Y	Y	Y	Y	Y
Wright, Andrew	DFO Maritimes / OESD	Y	Y	Y	Y	Y
Xu, Jinshan	DFO Maritimes / OESD	Y	Y	Y	Y	Y
Yeung, Jasmine	Dalhousie University / Biology	–	Y	–	–	–

APPENDIX C: AGENDA

Agenda

GULLY MPA MONITORING REVIEW

18-22 January 2021

Virtual Meeting

DAY 1 (Monday, January 18, 2021)

Time	Topic	Leads
1:00 – 1:10	Welcome & Introductions	Chair, T. Worcester
1:10 – 1:20	Review of the ToR and Agenda	T. Worcester
1:20 – 2:00	Introduction & Overview to The Gully	T. Kenchington
2:00 – 2:30	Fish Indicators – 30 min	T. Kenchington
2:30 – 3:00	Discussion and Wrap up	Everyone

DAY 2 (Tuesday, January 19, 2021)

Time	Topic	Leads
10:00 – 10:10	Review of previous day	Chair, T. Worcester
10:10 – 11:00	Cetacean Indicators 1 – 50 min	H. Moors-Murphy/J. Stanistreet/C. Evers
11:00 – 11:50	Cetacean Indicators 2 – 50 min	T. Wimmer
11:50 – 12:05	**Break**	
12:05 – 1:00	Discussion	Everyone
1:00 – 2:00	**Lunch**	
2:00 – 2:50	Cetacean Indicators 3 – 50 min	H. Whitehead/L. Feyrer
2:50 – 3:40	Cetacean Indicators 4 – 50 min	H. Whitehead/L. Feyrer
3:40 – 4:00	Discussion and Wrap up	Everyone

DAY 3 (Wednesday, January 20, 2021)

Time	Topic	Leads
10:00 – 10:10	Review of previous day	Chair, T. Worcester
10:10 – 11:00	Oceanographic Indicators –50 min	L. Beazley/E. Head
11:00 - 11:50	Benthic Indicators – 50 min	E. Kenchington
11:50 – 12:05	**Break**	
12:05 – 1:00	Discussion	Everyone
1:00 - 2:00	**Lunch**	
2:00 – 2:50	Seabirds Indicators – 50 min	K. Allard/C. Gjerdrum
2:50 – 3:40	Stressor 1 - Underwater Noise – 50 min	J. Xu
3:40 – 4:00	Discussion and Wrap up	Everyone

DAY 4 (Thursday, January 21, 2021)

Time	Topic	Leads
10:00 – 10:10	Review of previous day	Chair, T. Worcester
10:10 – 11:00	Stressors 2 – 50 min	MPC
11:00 - 11:50	Stressors 3 – 50 min	MPC
11:50 – 12:05	**Break**	
12:05 – 1:00	Discussion	Everyone
1:00 - 2:00	**Lunch**	
2:00 – 3:00	Review of SAR	Everyone
3:00 – 3:15	**Break**	
3:15 – 4:00	Review of SAR and Wrap up	Everyone

DAY 5 (Friday, January 22, 2021)

Time	Topic	Leads
10:00 – 11:30	Review of SAR	Everyone
11:30 – 11:45	**Break**	
11:45 – 1:00	Review of SAR and Wrap up	Everyone / Chair

APPENDIX D: TABLE OF RECOMMENDATIONS

Suggestions from this 2021 Gully Monitoring Review to continue, remove, or modify the indicators outlined in the 2010 (Kenchington 2010, DFO 2010) Monitoring Framework. Proposed modifications were suggested by expert groups for specific indicators, but do not necessarily reflect the consensus views of meeting participants, particularly where objections are noted. A – (dash) indicates no entry for that cell.

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
Effects Indicators (1-29)							
1	Abundance of the Scotian Shelf population of Northern Bottlenose Whales (NBW)	Trend Monitoring, Effectiveness Monitoring	Increasing (but Scotian Shelf population still endangered)	Continue but modify wording slightly	Size of the Scotian Shelf population of NBW.	Is abundance the right word here? should it be related to population size?	–
2	Use of the Gully MPA by NBW, measured as the percentage of the Scotian Shelf NBW population within the Gully MPA.	Characterization / Trend Monitoring over long time scales [Ecological Performance Monitoring]	Consistent use over time	Modify	Habitat use within the Gully MPA by NBW. OR Proportion of time Gully MPA is occupied by NBW?	Clearly Gully is an important area but how does it function within a network of important areas? Indicator could be reframed to address connectivity between Gully and other areas. Intent is to capture the persistent use of the Gully by NBW.	–
3	Size, age, and sex structure of the Scotian Shelf population of NBW.	Trend Monitoring [Ecological Performance Monitoring]	There was an increasing ratio of mature males to female-juveniles over the period 1988–2019. Post-designation, there was an increase in older identifications and mature males, but this pattern is not strong and more analysis is required. There was also an increase in sightings of calves over the period 1988–2019, which were more frequently sighted in the Gully than other habitat areas.	Continue but consider including body size/ condition analysis in another health status indicator	–	Low data in some years and significant effort required to assess sex-age information but can provide a useful assessment of demographic trends Age structure will be important to continue to monitor and may benefit from new methods under development (Body) Size has not been measured for approximately 20 years. This could be updated using the same method as used in the 1990s (photographs from a position up the mast) or comparable methods (drones) and such an assessment could include body condition.	Do we have any source of data on body size/condition? Whether there is an affordable source of information that can be suggested should be taken into account.
4	Percentage of individuals in the Scotian Shelf NBW population showing fresh scars.	Effect Monitoring [Human Pressure Monitoring]	The proportion of most mark types (all but fin scars) increased over time, suggesting that older IDs are accumulating scars as they age and/or there are factors occurring outside the MPA that are	Continue but modify	Proportion of anthropogenic markings and rates of mark gain in the Scotian Shelf NBW population.	Wording on “fresh scars” is unclear and could be more specific to address the overall proportion of changes in gain rates relevant to threats from entanglement or other anthropogenic sources of injuries.	Monitor what as a proportion of anthropogenic marks? Need to be more specific. Note that the original indicator was related to fresh scars.

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
			influencing scarring in the population. The annual gain rate of anthropogenic marks is higher than PBR for NBW.				
5	Genetic diversity within the Scotian Shelf population of NBW.	Trend monitoring	N/A	Modify or remove	"Change in population structure" may be a more appropriate indicator, but requires ongoing data collection and analysis.	Genetic diversity in this population is very low, and unlikely to change without significant immigration. Monitoring gene flow among populations may be an alternative indicator.	–
6	Levels of contaminants in the blubber of individuals in the Scotian Shelf population of NBW.	Trend Monitoring	A few individuals had PCB levels approaching lower toxicity threshold for adverse health effects. However average values were above the molecular toxicity threshold, suggesting PCBs may be affecting physiological responses at a molecular and cellular level.	Continue but modify	Levels of contaminants in the Scotian Shelf population of NBW.	Reference to blubber in indicator could be removed as not relevant for all contaminants (e.g. trace elements are measured in skin tissue).	Could include consideration for other contaminants (e.g., PBDE, PTFE), trace elements, heavy metals, and microplastics.
7	Relative abundances of cetaceans (other than NBW) in the Gully MPA.	Trend Monitoring	Decrease in sightings of Humpback Whales, white-sided dolphins, and striped dolphins. Increase in sightings of Sowerby's beaked whales and pilot whales. Peak in Blue Whales in 2005 followed by decrease. No change in sightings in zone 1 for common dolphins and Fin Whales (decrease in whole of MPA).	Continue	–	–	–
8	Cetacean presence and activity in the MPA, year-round.	–	No obvious trends apparent, but data have not been analyzed to specifically assess trends.	Continue	–	–	After the 2010 monitoring framework, it has become clear that passive acoustic techniques can only provide presence/absence (not quantitative) information on cetacean activity. While recording instruments must be deployed in the MPA to monitor Indicator 47, it would be efficient to also use them to monitor cetacean activity.

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
9	Number of reported strandings of Scotian Shelf NBW.	–	There were no reports of strandings of NBW to the MARS hotline between 2004–2019 within 100km of the Gully MPA. Strandings refers to live animals stranded on land, e.g., on Sable Island. No strandings are possible within the open water of the Gully MPA itself.	Continue. Recommend combining indicators 9–12, as these aren't recorded in isolation.	Number of reported strandings, vessel strikes, gear entanglements or other human-related incidents of cetaceans in or near the Gully and of Scotian Shelf NBW elsewhere.	Regarding Indicators 9–12: Different kinds of incidents aren't reported in isolation from one another, they generally come into a central location. In addition, these are all impacts to these cetaceans and their overall health and as such should be considered cumulatively.	There are numerous indicators among the 47 recommended in 2010 that could be merged or separated out. Need to consider whether this is a worthwhile exercise.
10	Number of reported ship strikes on cetaceans in or near the Gully, and of strikes on Scotian Shelf NBW elsewhere	Kenchington 2010, p. 25	Interactions between cetaceans and human activities have been reported in the Gully MPA and the surrounding area	Continue. Recommend combining indicators 9–12 as these aren't recorded in isolation.	Number of reported strandings, vessel strikes, gear entanglements or other human-related incidents of cetaceans in or near the Gully and of Scotian Shelf NBW elsewhere.	Regarding Indicators 9–12: Different kinds of incidents aren't reported in isolation from one another, they generally come into a central location. In addition, these are all impacts to these cetaceans and their overall health and as such should be considered cumulatively.	See note above.
11	Number of reported gear entanglements of cetaceans in or near the Gully, and of entanglement of Scotian Shelf NBW elsewhere.	Kenchington 2010, p. 25	Gear entanglements between cetaceans and human activities have been reported in the Gully MPA and the surrounding area.	Continue. Recommend combining indicators 9–12 as these aren't recorded in isolation.	Number of reported strandings, vessel strikes, gear entanglements or other human-related incidents of cetaceans in or near the Gully and of Scotian Shelf NBW elsewhere.	Regarding Indicators 9–12: Different kinds of incidents aren't reported in isolation from one another, they generally come into a central location. In addition, these are all impacts to these cetaceans and their overall health and as such should be considered cumulatively.	See note above.
12	Number of reports of other interactions between human activities and cetaceans in or near the Gully, and of interactions with Scotian Shelf NBW elsewhere.	Kenchington 2010, p. 25	Interactions between cetaceans and human activities have been reported in the Gully MPA and the surrounding area	Continue. Recommend combining indicators 9–12 as these aren't recorded in isolation.	Number of reported strandings, vessel strikes, gear entanglements or other human-related incidents of cetaceans in or near the Gully and of Scotian Shelf NBW elsewhere.	Regarding Indicators 9–12: Different kinds of incidents aren't reported in isolation from one another, they generally come into a central location. In addition, these are all impacts to these cetaceans and their overall health and as such should be considered cumulatively.	One reason to have the four indicators separate is that it should encourage clarity in reporting the kinds of incidents. That has been lost here, despite the four being, for present purposes, separate. Note that the intent is to develop indicators for MPA monitoring and not cetacean monitoring more generally.
13	Coral distribution, density and size structure by species at selected monitoring sites within the MPA.	Kenchington 2010, p. 25	No repeat sampling funded	Modify	Expand list of species to include xenophyophores and sponge species	Target feeder canyon heads in Zone 2 for future characterization over repeat sampling in Zone 1 in short term (5 years).	This is baseline characterization rather than on-going trend monitoring.
14	Coral diversity at selected monitoring sites within the MPA.	Kenchington 2010, p. 25	No repeat sampling funded	Remove	–	Kenchington (2010) proposed monitoring "diversity" at a time when that was supposed to be a simple task.	–

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
						Subsequent studies (Kenchington and Kenchington 2013) showed that quantifying diversity is a far more demanding task than is generally realized. It is doubtful whether it could be quantified for any taxa in The Gully and monitoring changes over time is entirely out of the question.	
15	Proportions of live and dead corals, by species, at selected monitoring sites within the MPA.	Kenchington 2010, p. 26 Trend monitoring	No repeat sampling funded	Modify	Focus on *Paragorgia* sp. and *Keratoisis grayi.*	Longer post-mortem lifespan and higher abundance than other species.	–
16	Proportion of live corals at selected monitoring sites within the MPA that show zoanthid over-growths and the extent of over-growth in any affected colonies.	Kenchington 2010, p. 26 Trend monitoring	No repeat sampling funded	Modify	Focus on *Paragorgia* sp. and *Keratoisis grayi.*	Species found in high density on all transects proposed for monitoring on eastern and western canyon walls.	–
17	Relative abundances, size distributions, and diversity of selected groundfish and trawl-vulnerable invertebrate species in Zone 3 of the MPA.	Kenchington 2010, p. 26	–	Continue snow-crab survey monitoring in the MPA, but modify wording.	Tighten seasonal control over the surveys Change wording to: “Relative abundances of selected groundfish and trawl-vulnerable invertebrate species in Zone 3 of the MPA.”	The fixed-station sampling with a groundfish trawl that was proposed in 2010 has never been implemented. Instead, a snow-crab survey has been extended into the MPA since 2015. While the data series is short, it appears to show promise as an indicator of trends in the shallow ecosystems of Zones 2 and 3. To date, the stations have been sampled over a period extending from October to January. Tighter control would reduce noise in the data stream. All reference to diversity should be deleted for the reasons given under Indicator 14. Size distribution data are too limited for useful monitoring.	–
18	Relative abundances, size distributions, and diversity of selected longline-vulnerable species in Zones 2 & 3 of the MPA.	Kenchington 2010, p. 26	Halibut biomass appears to be increasing, both regionally and in the MPA. Catches of some other species suggest less-certain trends, mostly consistent with regional changes.	Continue monitoring at fixed station 85, but modify wording	Tighten spatial control over the survey sets Change wording to: “Relative abundances, of selected longline-vulnerable	The past survey sets have been distributed up to several kilometers away from the nominal station location, resulting in them sampling a wide range of depths, which adds noise to the data stream.	–

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
					species in Zones 2 & 3 of the MPA."	All reference to diversity should be deleted for the reasons given under Indicator 14. Size distribution data are too limited for useful monitoring.	
19	Relative abundances, size distributions, and diversity of selected trap-vulnerable species in Zones 1 & 2 of the MPA.	Kenchington 2010, p. 27	–	Remove	This indicator was discarded by 2012.	Further exploration of the proposed indicator revealed that strings of traps could not be hauled from deep water. Deploying traps with individual buoy-lines would have introduced too much rope into the MPA.	–
20	Relative abundances, size distributions, and diversity of selected mesopelagic nekton in Zones 1 & 2 of the MPA.	Kenchington 2010, p. 27	–	Implement but modify wording	This indicator has never been implemented, though a baseline has been established Change wording to: "Relative abundances, of selected mesopelagic nekton in Zones 1 & 2 of the MPA."	Recent research suggests that the mesopelagic nekton may be a major source of the energy supporting the NBW in The Gully. All reference to diversity should be deleted for the reasons given under Indicator 14. Size distribution data are too limited for useful monitoring.	–
21	Temperature, salinity, oxygen concentration, alkalinity, pH, light levels, chlorophyll pigments and nutrients in the water column within the MPA, including in close proximity to the seabed.	Kenchington 2010, p. 28	Increasing trends in subsurface and intermediate (50–400 m) temperatures were observed in the spring.	Continue/implement but modify	AZMP's sampling scheme should be modified in the future where the current 'SG' stations are repositioned. Discussion is needed on where stations should be repositioned avoid redundant sampling. Pigment data are collected at each station but analyses are not evaluated as part of routine monitoring. Analyses could be implemented, but requires staffing.	–	It was noted in the meeting that the extra 2 stations outside the canyon mouth are redundant, as they just give 3 stations within the same body of moving water, but we did not discuss putting the same sampling effort somewhere else, let alone where.
22	Temperature, salinity, oxygen concentration, light levels, chlorophyll pigments and nutrients in waters flowing into and past the MPA, as	Kenchington 2010, p. 28	Conditions in the Gully MPA (GULD_03) were similar to those upstream (LL_07), but were relatively dissimilar to those downstream (HL_06).	Continue	–	–	–

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
	measured on the Louisbourg Line, the Halifax Line, and the Extended Halifax Line.						
23	Physical (temperature, salinity, wind, height) and biological (ocean color) sea surface properties in the MPA and the surrounding region.	Kenchington 2010, p. 28	Sea surface conditions (SST, SSC) in the Gully were similar to those along the shelf break both upstream and downstream of the MPA.	Continue but modify	Height could be changed to altimetry (SSH). Some variables included in this indicator are not easily accessible (satellite salinity) or are, at present, of low resolution. Higher-quality products may become available in the future.	–	–
24	Weather conditions at the Sable Island weather station and at the Banquereau and Laurentian Fan weather-buoy sites, including wind direction and speed, air pressure and sea level air temperatures, plus, for the buoy sites, sea surface temperatures, wave height, and dominant wave period.	Kenchington 2010, p. 28	Not assessed	Implement but modify	Banquereau and Laurentian Fan should be removed from this indicator.	ECCC is responsible for the location of weather stations. Only data from Sable Island is evaluated by the AZMP.	–
25	Three-dimensional distribution and movements of water masses within and around the MPA.	Kenchington 2010, p. 29	Not assessed.	Implement	–	This indicator has not been implemented. However, data on water masses within and around the MPA exist, and these data could be interpreted to implement this indicator. Future iterations of models describing the 3-D structure of water masses in the MPA should include a component on biogeochemistry.	–
26	Phytoplankton production, community composition and the timing of the spring bloom in the MPA and the surrounding region.	Kenchington 2010, p. 29	High inter-annual variability. No trends.	Continue monitoring of spring-bloom timing and implement monitoring of other parts of the Indicator as that becomes practical.	Remove phytoplankton production and community composition.	Phytoplankton production and community composition are more research-focused and not routinely monitored. Spring bloom metrics (start, duration, magnitude, amplitude) can be assessed by remote sensing.	–
27	Zooplankton biomass, community composition, and the biomass of selected	Kenchington 2010, p. 29	High inter-annual variability driven by variations in the timing of sampling relative to the lifecycles of	Continue	–	–	–

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
	species (e.g., *Calanus* spp. and carbonate forming) within the MPA.		the species, and their associations with different water masses.				
28	Acoustic scattering in the water column within the MPA (as a measure of mesopelagic and zooplankton densities and distribution).	Kenchington 2010, p. 30	Not assessed	Implement	–	This indicator could be monitored as acoustic platforms become available (e.g., moorings and vessels).	–
29	Distribution and abundance of seabird species within the MPA, including an index of planktivorous seabird species.	Kenchington 2010, p. 30	No evidence of trends, though formal analyses not yet undertaken on areal density, important habitat extent and biodiversity. No specific analysis performed on data for planktivorous seabird species (e.g. Dovekie).	Continue	There would be added value of additional survey effort toward enhancing indicator sensitivity, and incorporation of telemetry toward enhancing indicator specificity should be pursued.	–	Analyses could be focused on three KEAs. Avenues could be explored to derive an appropriate biodiversity indicator for Gully seabirds; however, one participant argued strongly against trying to quantify diversity (and "biodiversity" is inherently non-quantifiable; Kenchington & Kenchington 2013).
Threat Indicators (30-47)							
30	Number of transits through the MPA by vessels other than pleasure craft, such as mercantile vessels, surface naval vessels, and fishing vessels not fishing in the area.	Threat monitoring	This Indicator has only been quantified for commercial vessels and only for 2018 and 2019. They made a few more transits of the MPA in the latter year than in the former. Time spent by fishing vessels in the MPA (VMS data) decreased from 2011 to 2018.	Implement	Commercial vessels: Instead of the number of transits through the MPA by commercial vessels, unique vessels present per day and number of days with at least one vessel present in the MPA per month were used. This indicator did not previously include vessel speed, but this information is readily available within AIS datasets. Fishing vessels: Calculate the total time spent in the MPA while travelling at various speeds, rather than characterize each trackline as either fishing or not fishing.	–	Information on vessel speed may be available but may not be relevant. With rare exceptions, transits will be made at speeds above those that are thought safe for cetaceans. Further consideration needed on whether it is worth adding them to the formal Indicator. Fishing activity within the MPA is captured in Indicators 32, 34. What is needed here is movements, through the MPA, of fishing vessels that were not engaged in fishing and so not captured by those other indicators.

#	Indicator	Intent of indicator: (type: contextual; rationale; why we do it; etc.)	Trend or Amount (increasing, decreasing, unknown, N/A,)	2021 Recommendation (implement, continue, remove, modify)	Proposed Modification	Justification for Modification	Other Considerations or Alternative Views
31	Hours of operation within the MPA by vessels other than commercial fishing vessels or pleasure craft, broken down into research and monitoring vessels, other government vessels, and ecotourism vessels.	Kenchington 2010, p. 30	N/A Potentially relevant AIS data were reviewed for the first time at this meeting, and additional research/monitoring activity were identified during the workshop.	Implement	Hours of operation and average speed of vessels other than commercial fishing vessels or pleasure craft, such as research and monitoring, other government, and ecotourism vessels, within the MPA.	AIS data: These data were already downloaded for use in Indicator 30, so they could be easily analyzed for this indicator. These data can provide information about vessels that are not required to fill out activity reports, such as cruise ships and military vessels. AIS data also allow for the analysis of vessel speed, an important variable to consider when assessing the potential for disturbance caused by vessels within the Gully MPA.	The proposal in the 2010 Framework for the collection of data on the vessels that fall under Indicator 31 noted that they: "should only be in the MPA when operating there under permits." It was recommended that the permit conditions be expanded to require reporting of hours of operations within the MPA by each permitted vessel, with reports submitted to the MPA managers for compilation into annual summary statistics for Indicator 31. Military vessel are explicitly included under Indicator 30. Cruise ships not operating under MPA permits are covered by Indicator 30. Average speed may not be meaningful, when operations involve a mix of steaming at 10 knots and drifting while on station.
32	Commercial fishing effort within the MPA	Kenchington 2010, p. 31	Demersal longline effort in the MPA has decreased in 2012-2018 relative to 2005-2011, and pelagic longline effort in the MPA has increased in 2012-2018 relative to 2005-2011.	Continue	–	–	The report should be changed over time, potentially in annual increments, rather than grouped into 7-year blocks. This is one Indicator for which hard numbers are available.
33	Commercial fishing effort in close proximity to the MPA boundary.	–	Both demersal and pelagic longline effort surrounding the MPA have increased in 2012-2018 relative to 2005-2011.	Continue	–	–	–
34	Suspected and confirmed unauthorized fishing activity within or in close proximity to the MPA.	–	There were three incidents in the MPA during 2012–20, compared to five during 2004–12. Only one of the three involved additional fishing not recorded under Indicator 32: One vessel mistakenly towed gear	Modify	Unauthorized fishing activity within or in close proximity to the MPA.	DFO's Department Violations System's database cannot include information on unconfirmed suspicions and hence no analyzable data are available on those.	–

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			across the boundary into the MPA and self-reported the error.				
35	Quantities of corals removed from or discarded within the MPA by commercial fishing and by research activities.	Kenchington 2010, p. 31	During 2013-2019, four coral samples were collected for from the MPA for research and 12 sea pens were incidentally removed during trawl surveys. No coral removals or discards during commercial fishing activities were recorded.	Modify	Quantities of corals and sponges removed from or discarded within the MPA by commercial fishing and by research activities.	If adding sponges to the coral indicators, we might want to expand this indicator to include sponges too.	–
36	Quantities of target organisms removed from or discarded within the MPA, and of bycatch organisms (other than corals) removed from the MPA by commercial fishing.	Kenchington 2010, p. 31	Recorded landings from the MPA during 2012–18 totaled over 330 t, including 218 t of Atlantic halibut and 107 t of swordfish. Smaller landings of a dozen other species were recorded. The swordfish catch was higher than during 2005–11, while both the halibut catch and the all-species total were lower.	Continue	–	Data on discards are available from observers but have not been expanded into annual totals for all trip.	Indicators 35, 36 & 37 specify “Quantities” in part because the absolute quantity, not just the trend, is of interest.
37	Quantities of organisms (other than corals) removed from or discarded within the MPA by research activities.	Kenchington 2010, p. 31	8.3 t, including members of 92 species, were removed from the MPA by research and monitoring activities during 2013–19. Of that total, 5.3 t was halibut, almost all taken during the longline survey.	Continue	–	–	–
38	Seabed area swept by bottom-tending mobile research and monitoring gear within the MPA, both as a total and subdivided by seabed habitat type.	Kenchington 2010, p. 32	Between them, the snow-crab and Multispecies trawl surveys swept a total of 2.038 km^2 of the MPA during 2012–2020. These surveys (< 0.1% by area) of the Gully MPA. There are insufficient data to determine trends since earlier years.	Implement	–	–	The partitioning of this indicator into seabed type was not addressed at the CSAS, but this is considered to be an important element of the indicator as proposed in 2010.
39	Length of lines of, and seabed area occupied by, bottom-set fixed commercial fishing, research and monitoring gear set within the MPA, both as a total and subdivided by seabed habitat type.	Kenchington 2010, p. 32	1568 km of bottom longline in total were set in the MPA during 2012–18. Since halibut-longline effort has decreased, the length of line set was probably lower than in earlier years. Moorings for Passive Acoustic Monitoring sensors contacted < 11 m^2 of seabed during the same period.	Continue	–	–	–

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40	Number and types of offshore-petroleum exploration and development activities (e.g., number of wells, platforms, etc.) on the Eastern Scotian Shelf.	Kenchington 2010, p. 32	No wells have been drilled nor seismic surveys conducted within 50 km of the Gully MPA since 2012. All production-related activity on the Scotian Shelf ended in 2020.	Continue	Indicator states on the Eastern Scotian Shelf but during the last reporting period, a 50 km assessment area was selected - maybe increase assessment area and change wording of indicator?	–	–
41	Number, quantities and type of discharges from offshore-petroleum installations and activities on the Eastern Scotian Shelf.	Kenchington 2010, p. 32	A total of 2.14 L was spilt within 50 km of the Gully MPA during 2012–18, which was a decrease from previous years.	Continue	Indicator states on the Eastern Scotian Shelf but during the last reporting period, a 50 km assessment area was selected - maybe increase assessment area and change wording of indicator?	–	–
42	Number of ships' ballast-water exchanges in the proximity of the MPA and the quantities of ballast exchanged.	Kenchington 2010, p. 32	Information not provided.	Implement	–	–	–
43	Number, quantities, and types of other discharges from shipping within or in proximity to the MPA.	Kenchington 2010, p. 32	No incidents reported.	Continue	–	–	–
44	Quantity of floating debris (i.e., large objects) in the Gully MPA.	Kenchington 2010, p. 32	Preliminary analyses suggest a decrease in floating debris over time.	Continue	–	–	–
45	Quantity of anthropogenic debris on the seabed at selected monitoring sites in the Gully MPA.	Kenchington 2010, p. 33	This indicator was not reported on.	Implement	–	–	–
46	Reports of known invasive species in the Gully MPA.	Kenchington 2010, p. 33	No known invasive species have been reported from the MPA.	Continue	–	–	–
47	Quantitative characteristics of anthropogenic sound within the MPA.	Kenchington 2010, p. 33	Slight increase (approximately 0.30 dB per year) in low frequency (100–500 Hz frequency band) deep ocean ambient noise levels observed over a six year period.	Modify	Should consider two noise indicators: (1) trends in ambient noise levels; (2) rate of occurrence of acute anthropogenic noise events.	As noise may impact animals chronically or acutely, trends in ambient noise levels over time should be monitored and reported on, as well as the rate of occurrence of acute anthropogenic noise events.	–
Newly Proposed Indicators							

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-	Health of cetaceans in or near the Gully, and of Scotian Shelf NBW throughout their range.	–	–	Newly proposed indicator.	–	It is critical to monitor the overall health of the animals to fully understand the extent of human-driven effects. A complete picture of health can only be obtained through complementary health metric data collected from research from both dead (e.g., through necropsies) and free-swimming animals.	The cost of this proposed monitoring should be taken into consideration.
-	Measure basic contaminants in the Gully sediments (metals, HC, etc.) – could piggyback on existing benthic surveys.	–	–	Newly proposed indicator.	–	–	ROV sampling capabilities are limited and expensive, while an ROV that is running transects to record corals cannot be stopping to take samples. Drop-camera surveys cannot take sediment samples. Thus, while this sampling might piggy-back on other cruises, it would require extra ship time.
-	Concentrations of microplastics at fixed monitoring stations within the AOI.	–	–	Newly proposed indicator.	–	Since 2010, microplastics have emerged as a prominent threat in the marine realm and should be monitored within and outside of MPAs.	–